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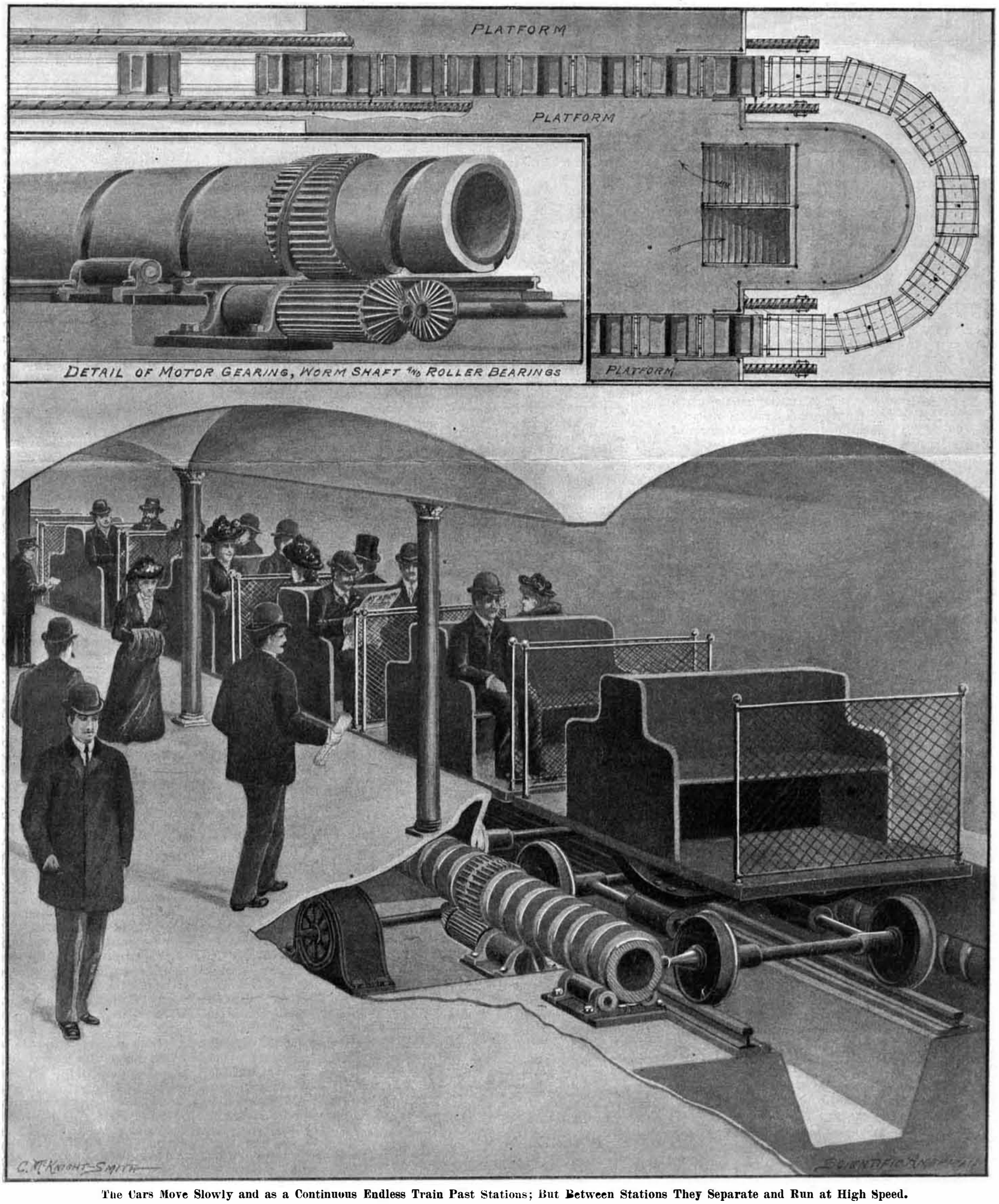
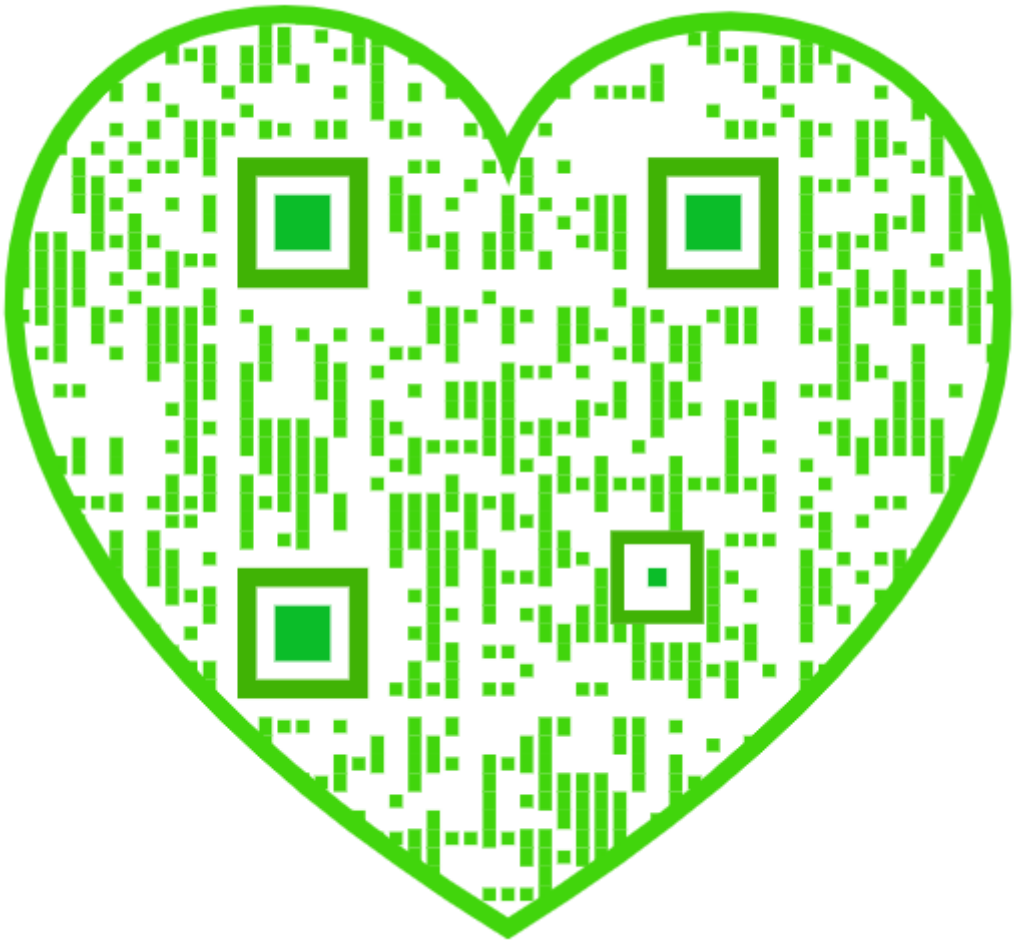
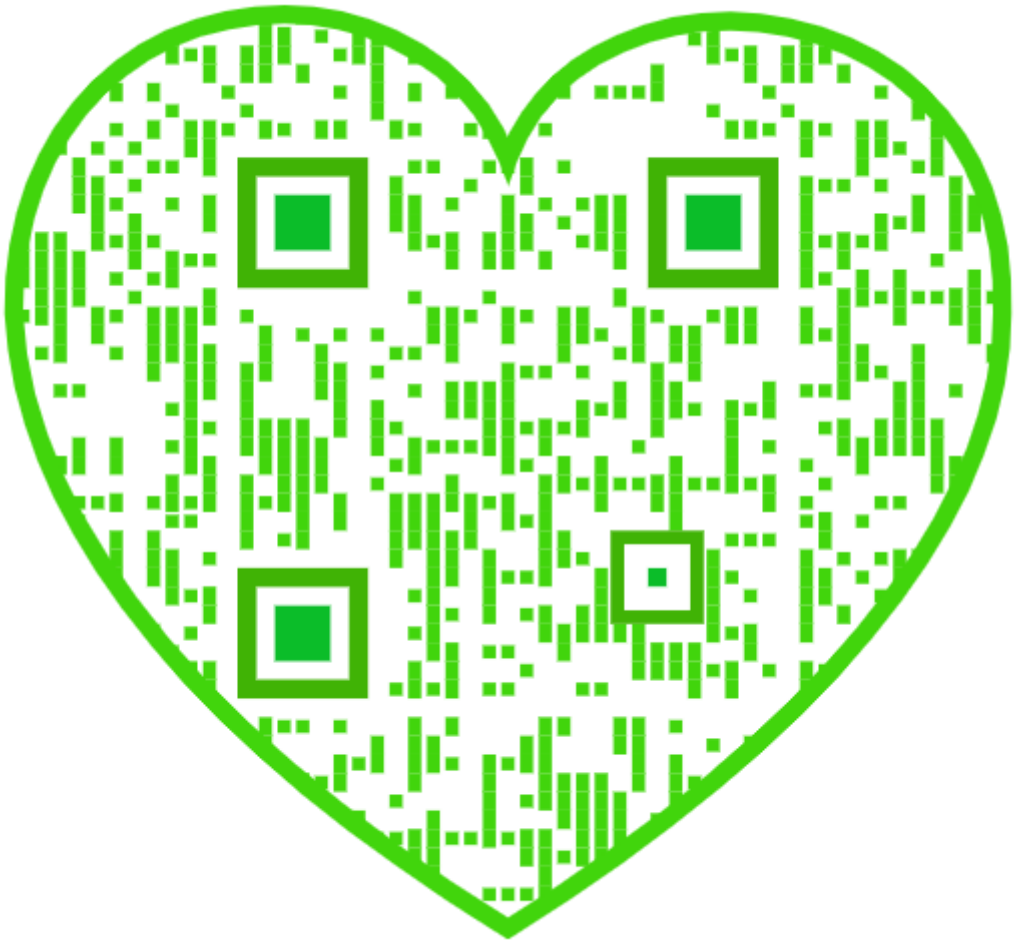


The Cars Move Slowly and as a Continuous Endless Train Past Stations; But Between Stations They Separate and Run at High Speed.

NOVEL RAPID TRANSIT SYSTEM OPERATED BY A CONTINUOUS SCREW WITHOUT MOTORS OR TRANSMISSION AND WITH NO RISK OF COLLISION.—[See page 291.]





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NEW YORK, SATURDAY, APRIL 6, 1907.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE SCIENTIFIC AMERICAN GOLD MEDAL FOR SAFETY DEVICES.

One of the most encouraging signs of the moral uplifting of the race is the unmistakable growth in these later days of the humanitarian sentiment. The dignity of the human body, the sanctity of human life, are swiftly emerging to their full and proper recognition. The reproach has lain too long at our doors that, as a people, we were so madly bent on the pursuit of wealth that we cared little who might fall by the way, if only the goal were swiftly and grandly won. To the question: "How much then is the life of a man worth more than that of a sheep?" we have made answer by rolling up a record of over half a million annual maimings and killings that may well put us to the blush.

Therefore it is gratifying to realize that the movement set on foot by the American Institute of Social Service for the promotion of an American Museum of Safety Devices is meeting with marked success.

In view of the fact that a very large percentage of these accidents is absolutely preventable, the editors of the SCIENTIFIC AMERICAN have decided to offer a gold medal, annually, for the best device for the protection of life and limb, produced during the year; said award to be given by the American Institute of Social Service, after the Board of Experts has passed upon the devices submitted.

THEORY AND PRACTICE.

In the current issue of the SUPPLEMENT we publish two investigations of the conditions existing, or presumed to exist, on the curve on which the recent derailment of an electric train took place on the New York Central tracks near this city. The first of these is concerned with the pressures of the driving wheels against the outer rail; the second determines the shearing strength of the spikes, which, by yielding, permitted the rail to be displaced. The investigation of the lateral pressure exerted by the drivers, which was made by George F. Swain, Professor of Civil Engineering of the Massachusetts Institute of Technology, shows that, under the conditions assumed, the leading outer driver, at a speed of 70 miles an hour, would exert a pressure against the outer rail not exceeding 3,500 pounds. The investigation of the shearing strength of six spikes showed that they gave way under an average shearing load of 19,740.5 pounds. This would indicate that, under the conditions assumed, there was a factor of safety of between five and six against failure.

Now, while Prof. Swain's calculations are absolutely correct, and it is shown that theoretically it was impossible for the electric locomotives to have sheared the spikes; as a matter of fact, the conditions assumed for his calculation never exist, and in the very nature of things cannot exist, in actual railroad operation—a fact which is recognized when Mr. Swain states in his report, that it is "not necessary to call attention to the uncertain elements involved." The low pressures arrived at would obtain, only if the curve were laid out with absolute mathematical exactness; if the superelevation of the outer rail were, at every point in the rail, of the exact theoretical amount for the curvature and the speed; if the density and elasticity of the rail were perfectly uniform; if the outer edge of the base of the rail were bearing snugly against every spike; if the ballast beneath every tie were tamped so as to give an absolutely equal amount of reaction of the ballast against each tie; and lastly, and perhaps most important of all, if the electric locomotive were built with absolute fidelity to the design, and all the parts of it were functioning with the accuracy of a high-grade watch; then, and only then, would it be safe to accept Prof. Swain's figures as indicating the actual pressures developed.

As a matter of fact, however, not one of the above-named conditions exists in actual practice, and in many of them, the divergence is apt to be very great indeed; moreover, where the divergence is of such a character as to permit what might be called the statical stresses of these calculations to be changed into dynamical stresses, that is to say, wherever slackness of adjustment, or irregularity of the vertical or horizontal contour of the rail, permits pressure to develop into momentum, the resulting stresses will immediately mount up far beyond the figures herein found for the condition of an ideal locomotive riding over an ideal track.

As illustrating what we mean, it is assumed in the investigations that the lateral displacement of the outer rail is resisted partly by the strength of the spikes, and partly by the friction of the base of the rail on the tie plate. The lateral pressure of the leading driver on the rail is found to be 8,400 pounds. The frictional resistance of the rail base on the tie plate is assumed to be 25 per cent of the vertical load of the driver, or 4,735 pounds, leaving a resultant pressure on the spike of about 3,500 pounds. But let us suppose that, as the combined effect of furious driving and of some irregularity in the track, such as a flattening of the curve, or a local sag in the grade, the locomotive should commence to surge heavily against the outer rail, and that the blow of this 95-ton mass, concentrated at a single point (the flange of the leading driver) should be sufficient, for an instant, to cause a slight canting of the rail, so that contact between base and tie plate was had only at the outer edge of the former where it impinged on the spike. In that instant of time, if the inner edge of the base rail lifted but a hair's breadth from the tie plate, the 4,735 pounds of frictional resistance would practically disappear (the laws of frictional area notwithstanding), and the spike would have to take nearly the whole 8,400 pounds of pressure direct. But the 8,400 pounds would no longer be a statical pressure, if we may apply the term, and the resultant dynamic stress, produced by the violently-lurching mass of the locomotive, might easily carry the figures up to two or three times that amount; in which case the 19,740 pounds resistance to shearing in the spike might be exceeded.

Now that such a condition is possible is shown by the fact that on the morning of the accident one of these electric locomotives, running around the curve, at about the point where the accident occurred, struck the outer rail a violent blow, rebounded, struck the rail a second time, and then after a few more oscillations settled down without leaving the tracks. The impact was so terrific that it was thought by those in the cab that a derailment was inevitable; and, on reaching the end of the run, the incident (as was stated before the grand jury) was telegraphed back by the engineman to headquarters. After such a terrific bombardment by a single locomotive, it is little matter for surprise that under a double-header running at what was probably greater speed, the spikes, possibly already partly sheared through, should have given way altogether.

As a matter of fact, we cannot call to mind in the whole field of engineering a single structural element regarding which it is so impossible to determine the actual stresses to which it is subjected as the modern steel rail carrying the heaviest and fastest modern traffic. It is at once the most important single element in the whole roadbed, the hardest worked, and, in respect of any serious effort, at least on the part of the rail mills, to bring it up to the requirements of modern traffic, the most neglected. The day is coming, if it is not already here, when that miserable blacksmith's contrivance, the common railroad spike, must give place to some form of screwed fastening with larger bearing surface and very much greater holding power.

THE FOUR-DAY LINER.

The possibility of the construction of a 30-knot liner, capable of crossing the Atlantic in four days, has recently been made the subject of discussion by the naval architect who was responsible for the design of the battleship "Oregon." This gentleman states that the plans are practically finished for the construction of a torpedo-boat destroyer of 625 tons displacement, and 12,000 horse-power, which is expected to be able to maintain a sea speed of 30 knots an hour. This will be sufficient to carry such a vessel over the transatlantic course of 3,000 knots in about four days' time. The interest of this destroyer lies in the fact that it is to be furnished with producer-gas engines, and that it will represent the first attempt to apply this system of propulsion to a high-speed vessel. According to the designer, the machinery will weigh only 210 tons, or about thirty-five pounds per horse power.

It is a far cry, however, from a 625-ton destroyer to a 20,000- or 30,000-ton transatlantic liner; and although the sponsor of this gas-plant vessel declares that he can produce 30,000 horse-power for a total weight of 500 tons in engine and gas plant, and that with a supply of only 850 tons of crude petroleum fuel, it would be possible to build a boat that would maintain a speed of over 30 knots for 3,000 miles, it is certain that such a vessel would be altogether too small to have any commercial value in the transatlantic trade.

Let it not be supposed, however, that we have any wish to disparage the enthusiasm of those who believe in the future of the producer-gas engine steamship. On the contrary, producer-gas engines, in the limited degree in which they have been installed afloat, have shown the same fuel economy and other desirable qualities that they have demonstrated in service on land. A well-designed producer-gas engine will develop a horse-power on one-half of the fuel that is necessary in a good steam plant. But up to the present time, these installations have been of small capacity, and they have been subject to the serious limitation that they are successful only when a good grade of anthracite coal is used in the producer; and, of course, no large ocean steamship could be regarded as a profitable venture, unless she were prepared, in common with the steam-driven vessels, to take the ordinary coal of commerce into her bunkers. At present there is no gas-producer which is capable of handling successfully bituminous coal, the problem of the by-products from such fuel remaining yet to be solved. The proposed gas-driven destroyer, however, is to make use of crude petroleum, and we understand that the experimental work that has been done with this fuel has given most promising results. If it should prove to be possible by the use of petroleum to produce plants in the larger sizes, which will provide the necessary volumes of gas to supply engines of the size requisite to drive a transatlantic liner, a most important step will have been made in the direction of the large four-day boat.

There will yet remain, however, for solution the difficult problem of building successful gas engines of the necessarily large size required for the development of 30,000 to 40,000 horse-power. For it may as well be set down, once and for all, that the units must necessarily be of large size, and this for the reason that for the propulsion of large vessels at high speed, a certain minimum diameter of propeller and maximum speed of rotation is imposed. Let no one imagine that the problem can be solved by the use of multiple gas engines, driving a plurality of small propellers at high speeds of rotation. The same propeller restrictions which necessitated the 20,000-horse-power turbines of the "Carmania" being designed for such a low speed of revolution, and, therefore, of such great size, that they practically equaled in weight the reciprocating engines of the sister ship "Caronia," will apply in the case of the gas-driven ocean liner. For a 30,000 or 40,000-horse-power producer-gas plant, then, the cylinders will have to be of unprecedented size and weight, and this will bring the designer up against some very serious problems in cooling. Not only must the huge superficial area of the cylinders be cooled, but so also must the piston rods and pistons. Equality of expansion and the prevention of eccentricity of expansion would be an absolute necessity. However, in view of the ingenious design and marvelous accuracy of workmanship displayed in the development of the large-powered turbine, we have little doubt that ultimately the problem of the large-powered gas engine will be solved also, and that the four-day transatlantic liner will take its place as the rival, if not the successor, of the turbine-driven vessels. The advantages secured will be many and gratifying both to the shareholders and the traveling public. If petroleum fuel should be used, the present large bunker space would be available for passenger and freight accommodations, the fuel being carried in the double bottom of the ship. The dirt, dust, and odor incidental to the coal, smoke, and ashes of coal fuel would disappear, as would also the enormous smokestacks, which not only disfigure steamships, but in view of the enormous and little appreciated wind resistance, consume a not inconsiderable proportion of the horse-power.

THREE MONTHS OF DENATURED ALCOHOL.

Although barely three months have elapsed since the Tax-Free Alcohol Act went into effect, the time has been sufficient to demonstrate certain possibilities of the industries favored by the bill, and to indicate some phases of the law which are either inadequate or fail to meet the conditions called forth by the use of the tax-free spirit for specific purposes. It can fairly be said that, in general, the operation of the law promises to be satisfactory, and with a few amendments, it will doubtless successfully fulfill its purpose in all particulars. As was to be expected, the law became operative without the revolutionizing of American industrial and agricultural conditions prophesied by numerous too-ardent advocates of the measure. The Standard Oil Company, which controls our gasoline supply, is still apparently in as flourishing a condition as it was prior to the first of January, and the farmers, with few exceptions, are still utilizing their waste products for purposes other than the distillation of alcohol. Many manufacturing industries, it is true, have enjoyed the immediate beneficial

effect of the new law, and have received a healthy stimulus, which has not been without its effect on the general financial and industrial condition of the country. Even the wood-alcohol interests, which opposed the passage of the bill so strenuously, have not suffered as severely as they declared they would; for wood alcohol, which is one of the standard denaturants required by the regulations, will be increasingly in demand with the wider utilization of denatured spirit.

It is possible to-day to obtain denatured, high-proof spirit for 35 to 40 cents a gallon, depending upon the locality in which the purchase takes place and upon the quantity bought. In New York city, for instance, denatured spirit can be purchased for 36 cents a gallon in five-barrel lots.

These figures are not discouraging, though they hardly permit the present general use of alcohol for fuel for motor purposes in competition with petroleum and gasoline at, roundly, 15 and 20 cents a gallon respectively. They indicate that the future of fuel alcohol is quite as promising as its more conservative advocates claimed prior to the legislative action. There can be no doubt that the price of the denatured spirit will decrease with the development of its industrial utilization, with the wider application of wastes to distillation, and with the growing familiarity of the farmer and the manufacturer with the subject.

Shortly after the alcohol bill became a law, the Department of Agriculture appointed a commission to conduct a series of investigations upon alcohol engines and the use of alcohol in ordinary internal-combustion motors. An interesting preliminary report, to be followed, before long, by a more elaborate account of the investigations, has recently been published. It presents much interesting data and substantiates, in general, the results obtained in Europe and the deductions to be drawn from them. The conclusion, previously arrived at by other investigators, that practically any explosive engine is adapted to the use of alcohol, but that the motor designed specially for alcohol will give superior results, is substantiated. One interesting fact is brought out which, perhaps, has not received a great deal of attention hitherto. This is that the possible margin of inefficiency is much higher in the alcohol engine than in other internal-combustion engines. With good management the consumption of alcohol in an engine not especially designed for the purpose can be brought as low as 1.23 pounds per brake horse-power, though the fuel consumption in the same motor may increase to nearly twice this minimum amount without apparent defect in the operation of the engine. This fact serves excellently to emphasize the necessity for using the specially-designed alcohol motor in order to obtain the best results with this fuel.

The prospect of producing denatured alcohol on the farm economically has been greatly brightened by the recent passage of a bill amending the Free Alcohol Act. Under the latter there was no adequate provision whereby denatured alcohol could be produced on a modest scale, as it was required that the pure spirit be removed from the still in barrels to denaturing warehouses. The amendment makes it permissible to transfer the pure spirit to denaturing warehouses by means of pipe lines or tank cars. Furthermore, it is provided that at distilleries producing alcohol for denaturation only, and with a capacity of not more than 100 proof gallons per day, bonded distillery warehouses may be dispensed with, and the alcohol may be stored in cisterns or tanks and denatured without removal to a denaturing warehouse. Both of the amendatory provisions will be of service in reducing the cost of manufacturing tax-free spirit, and the second will render its production practicable on a far smaller scale than was possible under the original law.

A great deal of independent experimentation has been carried out in all parts of the country for the purpose of discovering or demonstrating the possible use of various waste materials for alcohol production, and valuable data have been obtained in this way. Contrary to expert opinion, it is held by government officials and others familiar with the conditions, that under the law as it now stands, the farmer can successfully distill and denature alcohol from his produce or wastes on a small scale. Speaking recently on this topic, Internal Revenue Commissioner Yerkes declared that there were absolutely no limitations as to the size of a distillery which may be operated under the law. He declared, furthermore, that there are in existence at the present time over a thousand distilleries, of which the daily spirit-producing capacity is less than 30 gallons each, and that many of these plants were installed at an outlay of less than $200. We believe, however, that the successful solution of the problem of farm distillation on a small scale lies not in the use of a low-capacity still by the individual farmer, for the utilization of the produce or wastes from his own land, but is to be found in the communal still, operated jointly by a number of individuals or conducted by a distiller and operated on shares, the distiller being paid for his work in the resulting spirit itself, somewhat as the old-time miller received payment for grinding the grain, in flour. Even if small distilleries can be installed at a comparatively low cost, alcohol can be distilled economically and profitably only when the production is continuous and on a larger scale than is possible on the average farm.

Prior to the passage of the present law the American literature of industrial alcohol was, naturally, extremely limited, and strange to say, this is true to-day of England, despite the fact that the latter country has had tax-free alcohol for many years. Recently a number of books have appeared, dealing with different phases of the subject, and providing in many instances excellent means for the education of the layman and proving of value even to the expert. Among these we call attention to "Industrial Alcohol, Its Manufacture and Uses," a practical treatise, recently issued by the publishers of the SCIENTIFIC AMERICAN, and described at greater length elsewhere in this number.

THE EVAPORATION OF SOLID METALS AND THEIR COMPOUNDS.

The evaporation of metals at ordinary temperatures, which has long been conjectured from their characteristic odors, has recently been clearly demonstrated by several methods.

Zenghelis's method is as follows: The metal is placed in a saucer in an air-tight glass vessel which also contains a piece of chemically pure silver foil, suspended horizontally above the metal under investigation at a distance from 1-25 to 4-10 inch. Silver was selected as the material of the foil because it does not oxidize rapidly and exhibits considerable affinity to non-metals. Its effect is to increase the evaporation from the other metal by absorbing the vapor as it is formed, so that the volume of the containing vessel never becomes saturated.

Many experiments were made, with copper, lead, iron, zinc, the non-metals sulphur, selenium, tellurium, and phosphorus, the metalloids arsenic and antimony, and various oxides, hydrates, sulphides, and haloid and oxygen salts. In nearly every case the silver foil was more or less affected. Usually a golden tint, resembling that of an alloy, gradually extended inward from the edge until it covered the entire surface, but every color of the rainbow appeared in the course of the experiments. The metals were employed in the form of plugs, most of the compounds were powders obtained by precipitation, and some of the oxides were formed by roasting.

Weeks or months were required to produce a distinct effect with most substances, though a few days or even hours sufficed in some cases. The metalloids and non-metals, having a greater affinity for silver, acted more energetically than the metals. Phosphorus made the foil brittle throughout.

Among oxides the most rapid evaporation was shown by those of zinc, iron, chromium, uranium, and bismuth. Analysis of the foil that had been exposed to the vapor of zinc revealed the presence of 2 per cent of that metal. In most other cases the fact of evaporation was confirmed by simply determining the increase in weight of the silver foil.

No evaporation from quicklime or carbonate of lime was detected, while the sulphides of arsenic, antimony, tin, and barium evaporated very rapidly, comparatively speaking. Both sulphur and zinc were detected in the silver foil that had been exposed over zinc sulphide. In many cases the colors which occur on polished silver exposed to traces of sulphureted hydrogen were observed.

The haloid salts of lead, mercury, zinc, iron, and the alkali metals also acted very energetically, the iodides evaporating more rapidly and the chlorides more slowly than the bromides. With the haloids of silver, however, the order was reversed. The silver foil was completely corroded by long exposure over lead iodide.

The metals of the alkalies and alkaline earths were easily detected in the foil by the color of the blowpipe flame. In some cases in which the balance gave no result the presence of foreign metals in the foil was detected by the production of characteristic colors with appropriate reagents—potassium ferrocyanide for copper, iron, and uranium, sodium molybdenate for tin.

When copper, nickel, or aluminium was substituted for the silver foil no effect was observed. Gold was affected by the vapors of the oxides of zinc and mercury, but by no other substance.

The presence of moisture in the air of the vessel increased the rapidity of evaporation, and the water of crystallization of certain salts, including cobalt sulphate and chrome alum, had a similar effect. Rarefaction of the air also quickened the evaporation and the silver foil was attacked sooner in small than in large vessels. Evaporation was also favored by reducing agents such as hydrogen and alcohol vapor, but was not affected by covering the vessel with yellow glass to exclude the chemically active rays of light.

Elevation of temperature had no visible effect, probably because it promoted to the same degree the formation of vapor and the decomposition of the silver compound.

The golden metallic hue which was the first effect in nearly all cases, even when the substance under investigation was a compound, suggests an alloy of the silver with the other metal; and as the sulphides of arsenic, antimony, and tin produced colors indicating combination of sulphur with the silver, it seems probable that the vapors of compounds were dissociated as a result of their extreme rarefaction. This view is supported by the fact that the less stable of two related compounds attacks the silver more than the other. For example, the bicarbonate and the thiosulphate of sodium acted more quickly than the carbonate and sulphite respectively. Compounds that dissociate at low temperatures, such as hydriodic acid and oxide of mercury, also acted very quickly.

There is probably some connection between the evaporation of solid bodies and their long-known action on photographic plates. Many substances exert such action not only immediately after exposure to sunlight, but after they have long been shielded from light of every kind, and some of them affect the plate both when in contact with it and when separated from it by a layer of air. Zinc affects the plate at a distance of 1-3 inch, but magnesium and aluminium act more rapidly. Other substances possessing this property are wood, paper, leather, silk, cotton, shellac, and various metals.

The results of numerous experiments make it appear very probable that these effects are caused by invisible metallic radiations. These radiations are apparently subject to the law of gravitation, for when a metal plate is placed horizontally between two photographic plates the effect is confined almost wholly to the lower one of the latter. If the three plates are placed vertically in a centrifugal apparatus the photographic plate which is farther from the axis than the metal plate is more strongly affected than the other.

Streintz attributes this radiation to the agency of the so-called electrolytic pressure (which has been measured in the case of certain metals) and finds it proportional thereto. In the series platinum, gold, lead, iron, cadmium, zinc, aluminium, magnesium, the metals are arranged in the order of increasing electrolytic pressure and increasing effect on the photographic plate. According to Streintz, the effect of the electrolytic pressure is to expel positive ions which affect the plate, ionize the air, and leave the residual metal negatively electrified.

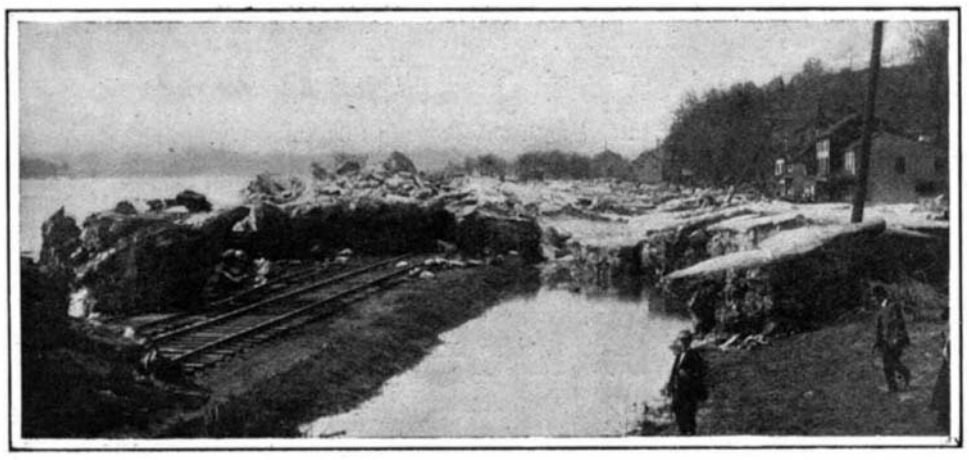
It appears probable, therefore, that evaporation, autophotography, and radioactivity are nearly related and are common to a great many metals and their compounds.

THE CURRENT SUPPLEMENT.

The current SUPPLEMENT, No. 1631, opens with an excellent article by Mr. Robert H. Chapman, of the United States Geological Survey, on the Deserts of Nevada and the Death Valley. In the management of wireless telegraph stations where open and closed oscillation circuits are compounded to form coupled systems for the efficient radiation of electric waves from an aerial wire, it is often necessary to determine with precision the frequency of the surging oscillations and the length of the emitted waves. This can be done by means of the ondameter or electric wave meter. Mr. A. Frederick Collins, in the current SUPPLEMENT, explains very clearly the principle of the ondameter's operation and its application in wireless telegraphy. Mr. Charles P. Steinmetz's excellent paper on light and illumination is concluded. Richard Lee writes on coal mine gases. The inundation of Salton Sink, and the formation of the great new lake in the Imperial Valley of California as the result of the diversion of the Colorado River, is very interestingly discussed by Mr. Arthur P. Davis, with the help of many excellent illustrations. Baron Suyematsu concludes his eloquent summary of the ethics of Japan. That the Romans were very good mechanical engineers has been proven by more than one striking discovery. How true this is may be gathered from an instructive article in the current SUPPLEMENT on an ancient Roman pump, which shows that long ago the Romans were very familiar with natural laws. On July 13 next the earth and Mars will be in opposition. At that time the much-discussed surface-markings of the planet will be observed. For that reason the very excellent article by the Abbé Moreux, director of the observatory at Bourges, on "The Planet Mars as Revealed by Recent Observations" may be considered a good preparatory discussion of a subject which will soon be dilated upon in the daily press. The abbé writes not only on observations of his predecessors, but on his own work. Sharp and clear illustrations accompany his offering. Interesting, too, is a report on the testing of railway spikes prepared for the New York Central and Hudson River Railroad.

A GREAT ICE JAM ON THE SUSQUEHANNA RIVER.

It is difficult to believe that the accompanying illustrations, showing the devastation wrought by great ice masses in the Susquehanna River, are from photographs taken in Maryland, a State which is seldom associated with rigors of winter such as these. Nevertheless, such is the case, for the photographs were taken at Port Deposit, Maryland, a short time ago. The huge masses of ice shown formed part of a great ice gorge which became jammed in the Susquehanna River, and backed up the flow of water from the freshets, causing extensive inundations. Considerable damage was done by the flood water and the large masses of ice, which were forced into the streets of the town and up on the railroad tracks, causing a temporary suspension of all traffic. In some places the ice was left piled on the railroad right of way when the waters receded to a height of 12 or 15 feet, and in places on the shore of the river, and even in the town itself, particularly at the upper end, to a height of 30 feet.



Part of the Ice Gorge Forced up on the Railroad Tracks.

The Story of the Brick.

BY PROF. EDGAR J. BANKS, FIELD DIRECTOR OF THE UNIVERSITY OF CHICAGO'S BABYLONIAN EXPEDITION.

The building brick is such a common thing that one may be excused for supposing that it always existed, and so simple that it needed no discoverer, yet there was a time when it did not exist. It was "necessity, the mother of invention" which called it, like many other things, into being. The recent Babylonian expedition of the University of Chicago, while excavating at Bismya, discovered that the brick was first employed in Mesopotamia nearly ten thousand years ago. In that level alluvial plain, absolutely without stones for building material, but with an abundance of clay, primitive man, when he wished for a house more substantial than one of reeds, constructed its walls of the common clay soil of the ground. Experience taught him that if the clay were molded and dried in the sun, it would be more durable. When he laid a chunk of moist clay in the sun to dry, he made the first brick.

In the lowest strata of the ruins of the exceedingly ancient city of Bismya, walls of these shapeless bricks were discovered; it was at a very early period that the Babylonians began to form the clay in a rectangular mold, as the modern Arabs of the desert still continue to do. During all of the period of Babylonian history sun-dried bricks, resembling the Mexican adobe, were employed, not only in the houses of the common people, but as filling in the interior of the walls of the temples and royal palaces.

The man who first discovered that bricks could be burned was that half-naked Babylonian of about 4500 B. C. who, while poking among the ashes of his old camp-fire, saw that the once moist clay beneath it had become hard and red. The first bricks which he burned were exceedingly crude in shape, flat on the bottom where the moist clay had rested upon the ground to dry, and rounded upon the top. Although the form was suggestive of the rectangular, the bulging sides gave it a somewhat circular appearance, as soft mud, if placed upon the ground to dry, would assume. These early bricks were small and thin, measuring about 20 centimeters in length and 5 in thickness, yet as time progressed they rapidly grew to about twice that size.

The modern manufacturer who stamps his name upon the bricks from his kiln, is but imitating the brick maker of six thousand years ago. The earliest known mark which appears upon the surface of the ancient brick was made by pressing the end of the thumb or of a round stick into the soft clay. As the bricks became larger, an interesting system of markings was adopted by the royal builders. The first mark of the series consisted of but a straight line drawn lengthwise along the surface of the brick; the next generation varied the mark by drawing a line diagonally, and the third added a diagonal line forming a Saint Andrew's cross. The fourth generation drew two parallel lines lengthwise upon the surface of the brick; the fifth drew them diagonally, and thus the series continued with three, four, and five lines until the dynasty came to an end.

Not far from 3800 B. C. the Semites invaded Babylonia, and Sargon, the king of about that date, modified the brick to a square shape, a form which has continued in the Orient to the present time. He also discarded the ancient system of brick marks to adopt a stamped impression of his name and titles. His son, Naram Sin, finding the large bricks of Sargon, which measured 42 centimeters square and 9 in thickness, too cumbersome, reduced them to about 32 centimeters square. A thousand years later, or about 2,800 B. C., the size had been reduced to about 30 centimeters, with the thickness of 6 centimeters. Thus they remained to the end of the Babylonian empire, and the palaces of Nebuchadnezzar at Babylon were entirely constructed of them.

The brick inscription, which first appeared in 3800 B. C., sometimes engraved but more frequently stamped, was not placed upon every brick of a structure. Naram Sin marked a few of his bricks with the brief legend, "Naram Sin, the Builder of the Temple of Ishtar." Of later kings the inscriptions, which were longer, appeared upon a greater number of bricks. I found in the Bismya temple about one of every twenty bricks of Dungi of 2750 B. C. inscribed with nine lines. Nebuchadnezzar stamped nearly every brick in his numerous vast constructions with a shorter inscription which read:

"Nebuchadnezzar, king of Babylon,
The restorer of the temples Esagil and Ezida,
The first born son of Nabopolassar, king of Babylon."

The mason of about 2800 B. C., while laying the square brick, found that to end the courses evenly, it was necessary to break a brick into halves. The manufacture of half bricks then began, and thus arose a brick of the shape and approximately the size of those employed in our own country and in Europe. Together with the half brick, as architecture became more complicated, the Babylonians employed other forms for binding the corners of walls, building columns and wells, and for ornamentation. Some were circular or semi-circular; some were wedge shape with a rounded base, or with the point missing; some were square, with one or more edges concave or convex, and of others a square from one corner had been omitted.

In laying the bricks those of a plano-convex shape, which were employed about 4500 B. C., were set in the wall upon one edge, and held in place with bitumen, the black pitch which comes from the hot springs at Hit upon the Euphrates, or more frequently with mud. While the use of both bitumen and mud continued, lime from the edge of the Arabian plateau was employed before Nebuchadnezzar's time. It is now the common cement of Mesopotamia.

Thus the brick and the brick stamp arose. Several thousands of years were required for its evolution from the lump of clay to the form which the Babylonians regarded as perfect. In durability and in the variety of shapes the skill of the early brick maker has never been surpassed. At Bismya we found bricks from 4500 B. C., as perfect as upon the day they were made, and our large desert house was constructed mostly of them. Our desert well was walled up with bricks five thousand years old, and they will still be perfect long after the ordinary brick from the modern American kiln shall have crumbled to dust. In the latter days of Babylon, after the process of glazing had been discovered, huge designs of animals in various colors were represented in relief upon the brick walls, and so perfect was the design that each brick was molded as carefully as the sculptor now shapes the various stones which are fitted together to form a richly carved monument.

To the archæologist this discovery of the origin and development of the brick and their stamps is of more than usual interest. It not only increases his knowledge of the life of early man, but what is more valuable, it presents him with a clue by which he may determine at a glance the comparative, if not the absolute age, of the ruins of the many buried Babylonian cities if only the fragment of a brick remains.

Ice Left in the Streets of Port Deposit, Md., by the Receding Waters.

A GREAT ICE JAM ON THE SUSQUEHANNA RIVER.

Cotton Baling and Car Shortage.

English purchasers of American cotton have long protested against what they regard as the inefficient and wasteful methods employed by American ginners in baling cotton, and are now pointing out that this is one of the causes for the shortage of freight cars in this country. There is certainly no excuse for the failure of American ginners to protect the baled cotton more thoroughly, especially in view of the fact that bagging is bought by the planter or ginner in the roll at a price lower than he gets for it on the bale—it then being weighed as cotton—yet they insist on not covering the sides of the bale. Egyptian and East Indian cotton is completely wrapped in heavy canvas.

As to the assertion that the American cotton bale could be reduced to the "compressed" size at the gin, it must be taken into consideration that most of the cotton is ginned in the country, by plants having limited power, power hardly capable of pressing the staple to a degree of density greater than at present employed in the planter's bale. If this could be done, it would certainly leave free for other commerce a large number of freight cars, as fifty bales could then be carried by one car, while at present but twenty-five can be hauled. With presses capable of baling cotton to a density of 35 pounds to the cubic foot, and shaping the bale in accordance with box-car measurements, 100 bales could be carried. The same remarks apply to cotton-carrying steamers, which, for instance, would be able to transport 12,000 bales, instead of 8,000 "compressed" bales as at present. The saving in the number of freight cars required to move the cotton can be appreciated when it is remembered that the usual crop is about 11,000,000 bales, which are constantly shifted from point to point. East Indian cotton is at present shipped to England in bales compressed to a density of 54 pounds per cubic foot; Egyptian cotton, 37 pounds; and American cotton, 23 pounds.

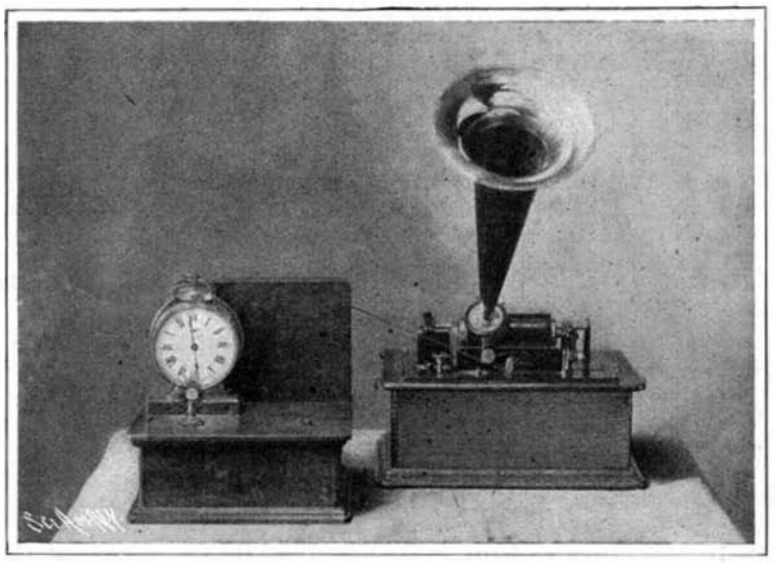
Walter Wellman is spending a few days in this country preparatory to setting out on his second airship expedition in search of the North Pole. During the winter he has had his airship reconstructed at Paris. It has been fitted with new motors, and its lifting capacity has been increased to 19,500 pounds. The airship will be shipped *via* Tromsöe, Norway, to Spitzbergen, where it will arrive about June 1. It will be put together and tested there, and if the tests are satisfactory, the flight to the pole will be made early in August.

A TIME-CONTROLLED PHONOGRAPH.

A recent article referring to the personality of Mr. Andrew Carnegie stated that the great ironmaster is awakened every morning by the melodious strains of a pipe organ, played by a well-known musician, and from a psychological viewpoint of theory and practice this is much better than to be rudely aroused to the day's activity by the clanging gong of a 98-cent alarm clock. Unfortunately all of us cannot afford the luxury of a private organ and organist, but thanks to the genius of Dr. J. E. Hett, of Berlin, Ontario, the next best thing has been done for a sleepy and long-suffering humanity, and that is a time-controlled phonograph, an arrangement of clock and phonograph, so that at any predetermined time of night or day, but especially in the early morning, sweet sounds may fill the sleeper's room and so awaken him.

Now the sounds that are first impressed upon the brain may be a march by Sousa or a song by Melba or any other musical selection that may be desired, and as it is generally believed that the first thoughts which are induced on awakening by external suggestion cling to a person more or less tenaciously throughout the day, it is obvious that these should be sweet and pleasant instead of harsh and uncomforting. To determine the correctness of the above supposition the doctor commenced a series of experiments, and as the result of numerous investigations upon himself he became convinced of the verity of it, and in the end devised the combination shown in the accompanying illustration.

The mechanism is very simple and consists of a spring which trips a lever attached at one end to an ordinary alarm clock, while at the other end a cord which passes over a pulley is connected to the starting lever of the phonograph. The case contains three ordinary dry-cell batteries, and when the alarm lever of the clock is tripped the phonograph is not only started but a miniature four-volt lamp is also turned on and lighted. The light may, however, be turned on or off at pleasure and the phonograph operated likewise at will.



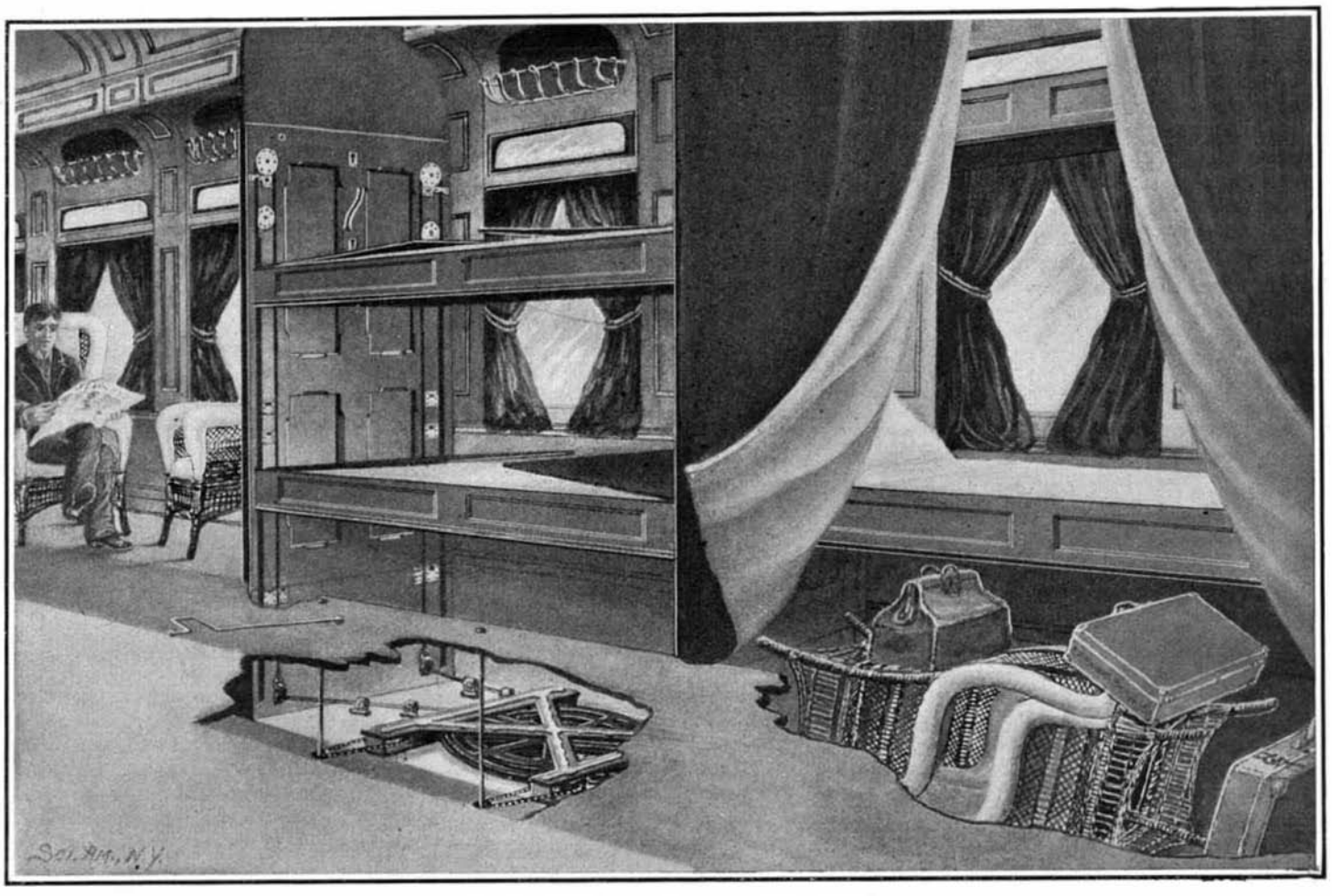
A TIME-CONTROLLED PHONOGRAPH.

A COMBINED SLEEPER AND CHAIR CAR.

Although the sleeping car is an American invention, and we are justly proud of it as such, we have yet to discover the traveler who finds pleasure in the use of one of these cars. There have been many complaints against the discomforts of this mode of travel. The berths are cramped and ill-ventilated by night, and by day the seats are cumbersome and hot. But the traveling public has continued to use these cars simply because nothing better was offered. However, a new car has recently been invented which promises much for the comfort of the traveler. A study of this new car merely emphasizes the discomforts which have so long been endured in other cars. The striking feature of the improved sleeper is the fact that when not in use the berths, both upper and lower, are lowered into wells under the floor of the car. Trap doors close these wells, leaving the entire floor free and unobstructed. Comfortable wicker chairs which occupy the wells when the berths are made up, are then provided for the use of the passengers.

The operation of making up a section occupies but little time. There are two trap doors to each well, one door overlying the other. These doors are hinged at opposite sides and when raised form the side walls of the section. The walls are carried up to the ceiling by means of extension pieces which are set into grooves in the upper edges of the trap doors and are cut to exactly fit the curve and moldings of the ceilings. Each door is provided near the upper end with two pairs of pulleys, one pair for each berth. Light wire cables attached to the berths at opposite sides pass over the pulleys and are carried down to a pair of drums, one for each berth, at the bottom of the well. Our illustration shows the floor of the car partly broken away to reveal these drums. The drums are normally concealed by a false bottom, which is not shown in the illustration. The drums are separately operated through suitable gearing by means of a pair of shafts, whose square ends project into recesses in the car floor. To turn the shafts the porter uses a hand brace of the form shown in the engraving. The berths are thereby lifted to their proper positions. The illustration shows the berths in one of the sections as only partly raised. It will be noticed that each berth is provided with a pair of hinged lids. When the berths are raised to the proper height, these lids are swung up against the walls of the section and serve not only to conceal the pulleys and cables, but to operate latches which enter sockets in the walls and thus firmly lock the berths in position. A cam groove may be seen in the upper end of the trap door, the office of this being to operate a board or slide that closes the gap between the upper berth and the side wall of the car. The lower berth before being locked into place is first raised sufficiently to permit of stowing away the wicker chairs and luggage. Then it is lowered to position and locked, as shown at the right of our engraving. The gap between the lower berth and the edge of the open well is closed by a shutter which slides under the berth. Between the curtains and this shutter is a space 8 inches wide in which suit-cases, satchels, and the like, may be placed without encroaching upon the aisle. An entire section, upper and lower berths, may be made up in from two to three minutes, and the entire car in less than half an hour, so that the passenger is not subjected to those long, wearisome delays to which he has heretofore been accustomed. There is over 6 inches more space between the lower and upper berths than usual, while the clear space above the upper berth provides plenty of room for the occupant to dress and undress. If only one berth of a section is to be occupied, the upper berth may be moved down on to the lower berth and locked in place.

In cars as heretofore made, the bedding, during the daytime, is placed in the upper berth and locked up against the ceiling. Here it must remain all day without ventilation. In the new car, on the other hand, the wells are provided with a ventilating system, so that the bedding is thoroughly aired all day. A novel ventilating system is also provided for the car itself, and due to the arrangement of the berths, larger windows than ordinary are provided. By storing the berths near the trucks, topheaviness of the car is prevented and a much lighter construction is permitted.



A COMBINED SLEEPER AND CHAIR CAR.

Sound-Proof Building Plates.

These bricks or plates are made from a mixture of gypsum, with sawdust, cokedust, or ashes. The following, according to the Bautechnische Zeitschrift, is another effective but more expensive method. An acid or acid salt from a second salt is mixed with the gypsum mass by stirring; the action of the acid forces out the carbonic or hydrochloric acid from this second salt, and these gases in escaping produce pores in the plates. With careful work, the pores in the mass may be distributed so evenly and in such great number that the plates made from it are very light, conduct sound badly, and can be easily nailed. The same result, according to the Allgemeine Chemikerzeitung, may be obtained in a much simpler manner by adding small quantities of carbonates to the gypsum mass. These carbonates and the gypsum suffer mutual decomposition, resulting in the liberation of carbonic acid; the gas escapes slowly and steadily, while the gypsum sets and hardens, acquiring an entirely porous texture without losing any of its durability. Thus at the expense of very little material the plates, while retaining their strength, become lighter. The bicarbonates of the alkalies—sodium carbonate or ammonium bicarbonate—are the best salts to use for the purpose. The effect may be increased by adding sawdust, cokedust, or ashes. For example, 20 parts by weight of sawdust may be mixed with 40 parts by weight of gypsum, and 40 parts by weight of water, in which 1 part by weight of sodium bicarbonate or ammonium carbonate has been dissolved, added to the mixture. The pulp is poured into molds, and can then be left to harden without further attention.

The Prussian government is said to have agreed to carry out the important works involved in providing a canal joining the Moselle and the Saar. The canalization works are, in fact, already in progress on the former river between Remich and Differdange. It is possible that the scheme will come before the Reichstag in the autumn of the present year.

THE CONSTRUCTION OF A MAGNETIC DETECTOR.

BY EDWARD G. GAGE.

The researches of Joseph Henry brought out the fact that the discharge of a Leyden jar through a coil of wire surrounding a needle produces an effect quite unlike that of a voltaic current. Instead of being uniformly magnetized, the needle is seldom magnetized twice alike throughout its length, and its poles are often reversed.

Although Henry rightly guessed the true cause of this irregular magnetization, namely, that the discharge is oscillatory, the principle was not applied by him in detecting oscillations at a distance, but Rutherford, some fifty years later, utilized this principle in his detector of electric waves.

A small magnetometer was placed near one end of the needle, previously magnetized to saturation, and the changes in magnetism caused by oscillations from the distant oscillator passing through the coil surrounding the needle were noted by the deflections of the magnetometer.

This apparatus was, of course, suitable for experiments only, in that a freshly magnetized needle was required after every discharge of the oscillator.

Marconi overcame this difficulty by supplying a constant source of variable magnetism in the shape of a permanent magnet, which, being slowly revolved by clockwork with its poles facing the coil of wire, supplied fresh magnetism to the core, which instead of a needle was now a bundle of thin iron wires.* As a further improvement Marconi discarded the magnetometer for noting the passage of oscillations, and in its place wound a second coil of fine wire over the first, which picked up the induced currents, and led them to a telephone receiver in which a click could be heard for every spark discharge of the transmitter.

Even this form of detector had its drawbacks, as the signals received were constantly varying, being strongest upon the approach of the magnet poles to the core, and weaker when receding, making it unsuitable for practical work. Again Marconi has overcome the difficulty by arranging the detector in the manner later described.

Although the operation of the magnetic detector is commonly called one of hysteresis, in which the magnetism of the core lags behind the magnetizing force of the permanent magnet, and is suddenly set free by the passage of oscillations through the primary coil surrounding it, the true operation, like that of the electrolytic detector, is disputed by several investigators.

It is sufficient, however, for practical needs to accept the hysteresis theory, and to so proportion the windings, core, magnet, etc., that they shall be best suited to a happy medium of wave lengths, telephone receivers, and signal strengths.

This has been accomplished in the modern commercial detector, which is due to Marconi, and is wonderfully constant, "fool-proof," and ranks next to the barretter or electrolytic detector in sensitiveness.†

Directions for making a home-made detector of this character are as follows:

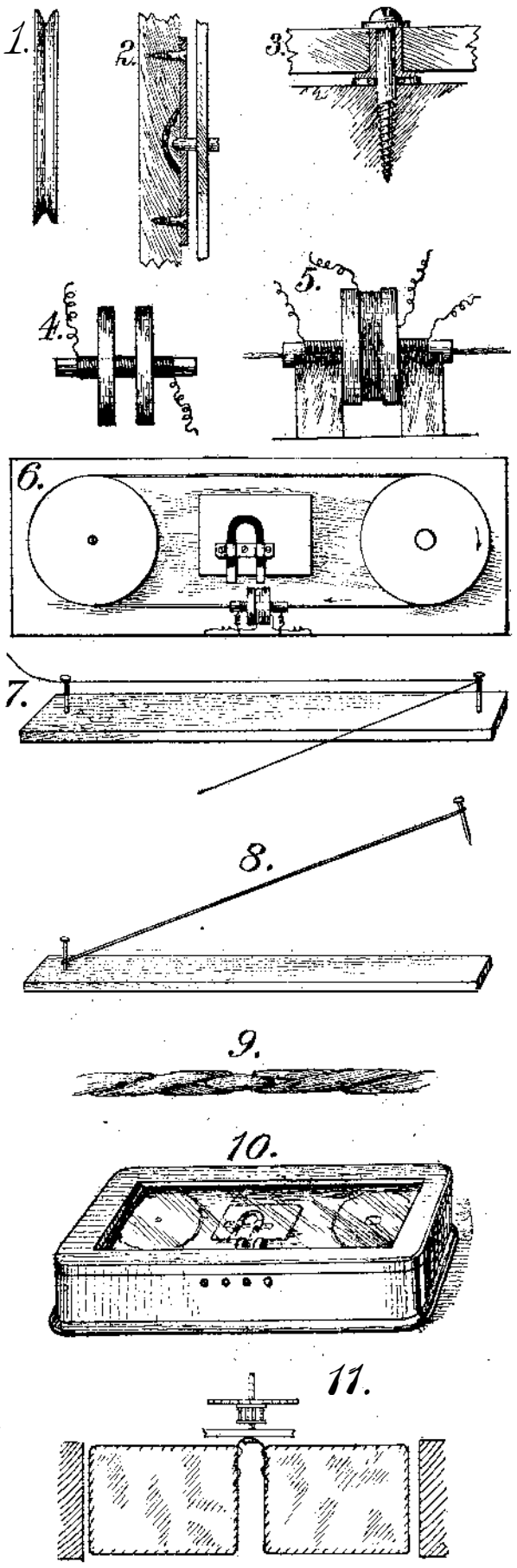
A suitable baseboard for the instrument is first selected from straight-grained pine, 18 inches long, 6 inches wide, and ⅞ inch thick.

Procure the works from an ordinary clock, preferably of the eight-day variety, although those from an ordinary alarm clock will be chosen here for the sake of simplicity. Remove the balance wheel and all unnecessary cogs, screws, etc. To one end of the spindle of the last cogwheel solder a narrow strip of tin 1 inch long and ⅛ inch in width, to serve as a dog to hold a wind-brake, this to cause the wheels to revolve slowly and quietly. The tin strip should have a small hole punched through the center and placed over the end of the spindle, which projects a trifle from the under frame. A small drop of solder will secure it, after which any form of small cloth or paper vane may be attached by a wire loop or frame. Owing to the difference in construction of various clockworks, it is difficult to specify any shape or position of the brake, but the one shown in Fig. 11 gives the general idea. Cloth over a frame is preferable to paper or cardboard, as it moves silently. Allowance should be made for the movement of the vane, either by cutting away the wood around it, or projecting the vane through a hole in the base, and supporting the whole instrument on a superficial base by means of cleats. The spindle to which the hands are attached serves for the driving shaft, and should be soldered to the cogwheel through which it passes, as ordinarily it is held by the friction of a spring pressing against it.

Two wooden disks, preferably birch, are now cut out 4 inches in diameter and ⅜ inch thick. Upon the periphery of each disk is cut a groove of the shape shown in Fig. 1.

From a piece of heavy sheet brass cut a square 2 x 2 inches and drill a ⅛-inch hole in each corner and one in the center to fit the driving spindle on the clockwork. Place in position on the spindle and fasten with solder, being careful to keep it true. Hollow out the center of one of the wooden disks sufficiently to contain the lump of solder so formed, and fasten it to the brass square by means of small steel screws passed through the hole in each corner (Fig. 2). A small magnetic screw driver will be found very useful for passing the screws into place through the open work of the clock frame.

The clockwork is now mounted on one end of the board, the center of the disk being 3 inches from the edge. Stove bolts passed through open parts in the frame from the bottom of the baseboard and fitted with nuts and washers will be found the best method of doing this. A hole should be bored in the baseboard immediately beneath the winding stem, to allow for the insertion of the key. Next cut a block of soft wood 5 inches square and of a thickness 1/16 inch less than the distance between the top of the baseboard and the under side of the mounted disk. The remaining disk is now fitted with a brass bushing and a 1-inch round-head brass screw selected to fit the hole in the bushing nicely, and passed through it into the block of wood just mentioned, placing a washer beneath the disk and one under the screw head (Fig. 3). Fasten the block to the baseboard in a position so that the distance between centers of the disk shall be 12 inches.



THE CONSTRUCTION OF A MAGNETIC DETECTOR.

This finishes the framework, and the coils should now be wound and adjusted. Obtain a piece of annealed glass tubing, as thin as possible, 2 inches long and ¼ inch external diameter. Hold the ends in a Bunsen flame just long enough to smooth the rough portions, flaring one end slightly with a small stick of wood. This prevents chafing of the iron rope.

In winding the primary coil over this tube it is a good plan to tie the ends tightly with thread, to prevent slipping. The wire used should be No. 36 silk-covered, and should measure 10 feet in length. It is wound in a single layer as closely and evenly as possible, leaving 6 inches of the wire at each end for connecting. The coil when wound should occupy a space of 1½ inches in the center of the tube. Give the whole a good coat of shellac and allow to dry.

Over the coil and tube so formed are slipped two small disks of ¼-inch soft wood 1½ inches in diameter (Fig. 4). The hole in the center of the disks should be just large enough to fit over the coil tightly, and shellac used to hold them in place. They should occupy a position in the center of the tube, being set ⅜ inch apart. When they have become firmly fastened in place the space between them is wound full of No. 36 silk-covered wire, leaving free ends about a foot long for connecting (Fig. 5).

Tube and coils are now placed in position on the baseboard so that the interior of the tube is in line with the grooves on the periphery of the disks, and the coils midway between them (Fig. 6). Support the tube on a pair of blocks, as shown, using a liberal amount of shellac to hold it in place.

Cut out another wooden block 4 inches long, 2 inches wide, and of about the same height as those supporting the tube. Fix this block lengthwise in the center of the baseboard. Procure a small permanent magnet of the horseshoe variety, and mount it on the block in such a position that its north pole will be pointing directly in front of and nearly touching the outside turns of the secondary coil (Fig. 6), while its south pole will be opposite one end of the tube. If the disk on the clockwork revolves from right to left (as it ought), the south pole should be to the left of the center of the tube and coils; if in the opposite direction, to the right. It is immaterial which pole is in front of the secondary coil, as long as the remaining pole is in the proper relation to the direction of the moving band, about to be described. The commercial instrument is fitted with two magnets, like poles adjoining, and facing the center of the secondary coil, but the difference in effectiveness of this arrangement is so slight as to be unnoticeable.

We now come to the last, and if not properly made, the most difficult and exasperating part of the detector, the moving band or rope of iron wire. To the uninitiated this has always been a source of great difficulty and annoyance, and though simplicity itself when made in the following manner, attempts at other methods are almost sure to result in a bungling, tangled mass of stray loops and ends.

The wire of which the band is made is No. 36 silk-covered, iron wire. Select a soft pine board ⅞ inch thick about 3 feet long and 4 inches or 5 inches wide. Drive two nails to a depth of ½ inch in the board at a distance apart equaling twice the circumference of the oval formed by the two wooden disks, when measured by a string passed around the grooves. Starting at one nail (Fig. 7) wind the wire from one to the other, always winding in one direction; that is, so as to inclose the two nails in a narrow coil of wire. When the total number of strands equals 100 the ends are connected, and one nail is cautiously withdrawn from the board, keeping the wire still on it, and drawn taut (Fig. 8). Twist the strands into a rope, keeping them taut, and remove the remaining nail from the board. Both nails are now removed from the ends of the band, being careful not to disturb the loops formed by them. Thread the band through the glass tube, passing it around both pulleys and bringing the ends together between them. The two ends are linked together by threading a separate piece of the iron wire through and through them (Fig. 9), drawing tight after each threading, and connecting the ends of the wire by tying or twisting, as in the case of the band.

This completes the working parts of the detector, and any casing may be fitted to it and finished according to the ideas of the operator.

A good casing is made by fitting the sides and ends with ⅜-inch hardwood strips extending ½ inch above the surface of the disks. This forms a box with the top open, and a nice-looking instrument is made by attaching a glass door by hinges to cover it and protect the working parts from dust and injury (Fig. 10).

The ends of the primary coil are brought to binding posts in the side of the box nearest them, and those of the secondary connected to another pair of binding posts, one on each side of the first two. If desired, a false bottom of pressboard can be fitted beneath the disks, leaving only the coils and tube, magnet, band, and disks visible.

It will be noticed in the case herein cited that the winding stem is situated in the base of the instru-

* See paper by Marconi before Royal Inst. of Great Britain, June 13, 1903, in Electrician June 27, 1903, p. 388.

† The recent introduction of the compound of silicon and carbon as a detector of electric waves, and also a modified form of Fleming's rectifier used for the same purpose, renders this statement liable to error.

ment—a great inconvenience that can be remedied only by gears or ratchets; but this is hardly worth while, in view of the great advantage to be gained by using an eight-day clock, which, in addition to its ability for long running, usually has the winding stem on its face. The proper speed of the driving disk is that which will cause the moving band to complete the circuit through the tube in about two minutes.

Aerial and ground are connected to the terminals of the primary coil, and the telephone to those of the secondary. An almost inaudible hissing sound, in the telephone, as the band slowly threads its way through the tube and around the pulleys, shows the detector to be in working order.

A CONTINUOUS VARIABLE-SPEED SYSTEM OF RAPID TRANSIT.

Most of the transit evils from which every crowded city suffers are due to the periodic character of the train service. The steady current of people that pours into the station must be periodically checked to await the arrival of the trains. It is this intermittent damming of the human stream that produces the rush-hour crush, and retards, as well, the unloading and loading of the cars. The only remedy possible under the periodic transit systems is to reduce the headway of the trains so as to carry off the crowds at more frequent intervals. But the headway cannot be cut down below a certain minimum determined by the length of time required to load and unload the cars, plus a constant allowed for starting and stopping. This minimum has already been reached by the New York Subway express service where, at certain hours, three and four trains are sometimes stalled waiting their turn to enter a station.

Realizing that we have reached the limit of possibilities of an intermittent or periodic service, the next logical step would seem to be in the direction of a continuous transit system. Several such systems have been proposed. The moving platform, consisting of three endless platforms traveling side by side at rates of three, six, and nine miles per hour respectively, is familiar to our readers. Another, and a most unique plan which was recently described in these columns, consists in an endless chain of cars traveling at a speed of, say, 20 miles an hour, and to which access is had by means of a large whirling platform with a peripheral speed equal to that of the chain of cars, but with a speed so reduced near the center where the station entrance is placed that the platform can be here readily boarded.

Still another continuous scheme has just been brought to our attention which is decidedly novel in many respects. It is the invention of two engineers of this city, Messrs. B. R. Adkins and W. Y. Lewis. In this system a series of short cars are used, which travel at high speed between stations, but slow up while passing a station platform to permit the passengers to alight or step aboard. In this respect the system resembles that of separate trains. However, the cars do not stop at the station, but come together to form a continuous train or moving platform traveling at a rate of three miles per hour. Once the station is passed the speed is uniformly accelerated up to say 21 miles per hour, hence the cars successively break away from the close formation and are strung out all along the line until the next station is approached, when they again draw together and pass the station as a continuous train. In other words, the cars run under a headway much smaller than the present minimum because they do not stop at stations, but merely slow up. Furthermore, this retardation is of known duration, whereas in the ordinary periodic system it is a very uncertain quantity depending upon the size and compactness of the crowd which desires to get on and off.

The method of driving the cars at this variable rate is very simple. On each side of the track, extending along the entire length of the line, is a pair of screws, or rather shafts, in each of which a spiral groove is cut. One of these is formed with a right-hand spiral and the other with a left-hand spiral. These opposed spiral grooves receive the opposite ends of the forward axle of each car, so that when the shafts are turned in opposite directions they feed or "screw" the cars forward. The desired acceleration or retardation of the cars is produced by varying the pitch of the grooves.

We are accustomed to think of screw and nut gear as adapted only for very powerful but slow motion, and it may at first sight seem to be impracticable to obtain a high speed without considerable friction, also impossible to obtain such a variation in feed as between three and twenty-one miles per hour on the same screw. However, this detail has been quite carefully worked out. The inventors propose to use a shaft 18 inches in diameter. At the slow-speed points the groove would have a pitch of 7.5 inches, while at high-speed points the distance between threads would be 52.5 inches, and the maximum speed of travel stated could then be obtained by driving the shafts at 422 revolutions per minute. The angle of the groove with the axis of the screw at maximum and minimum pitch is 45 deg. 20 min. and 8 deg. 15 min., respectively, while the screw efficiency is 96 per cent and 86 per cent, respectively, because the friction is almost entirely eliminated by using ball-bearing rollers on the axles to engage the spiral groove, and the shafts are carried in the well-known "anti-friction" roller bearings.

The screws or driving shafts are supported at frequent intervals on rollers, as shown in one of the figures of our front-page illustration. They are driven by electric motors at various points along the line, say one-fourth of a mile apart. Each motor drives a short power shaft which passes under the track at right angles thereto. By means of bevel gears the power is transmitted to a pair of short drive shafts parallel with the screw shafts. The drive shafts are fitted with broad-faced spur gears which mesh with toothed collars secured on the screw shafts. As is clearly shown in our illustration, the spiral groove passes right through the gear collars. The shaft is made in short lengths of, say, 25 feet, which are spliced together with a lap joint. An axial play of one-sixteenth of an inch is allowed at each joint for expansion and contraction. At suitable points along the line thrust collars are secured to the shaft and these are engaged by rollers which take up the end thrust.

It is the plan of the inventors to inclose the screws on each side throughout the length of the lines, providing a platform level with the car floors, so that in case of stoppage the passengers can leave the cars and walk along the platform to the nearest station. The rails are supported on a concrete bed, which is molded to form a deep trough or open conduit in which workmen can walk while cars pass over them. Should a passenger fall between the cars the latter would pass over him without doing him any injury; also, if a parcel should be dropped from the cars it would fall into the conduit without obstructing the track.

The cars are short, four-wheeled vehicles with two seats placed back to back. They are open at the sides and closed at the front and rear by means of wire screens. At stations a platform may be built on both sides of the track, so that passengers may enter or alight from either side of the car.

A system of this sort is, of course, unsuitable for any but a straight track because the shafts cannot be bent around curves. Yet the inventors propose to negotiate slight curves by laying straight lengths of shafting on chords of the curve and gearing these chords together. The cars may be carried past joints in the chords by their momentum, or by a clutch device which will act automatically. Some such scheme would also be necessary on a straight line to pass over a rise or a dip in the track.

Very evidently, as this is a continuous system, the track must be endless; that is, at the ends of the course the "down" and the "up" tracks must be connected by a curve. A number of schemes have been devised for carrying the cars around the connecting curve. The best plan seems to be the use of a wheel with an automatic clutch which seizes each car just as it leaves the screws and carries it around to the return screws.

The following are some of the advantages of this continuous variable-speed system: It does away with motormen, conductors, and guards, hence greatly reducing operating expenses. The entire line is operated from a single power station. As the shafts run continuously at constant speed, the load is almost constant, varying slightly with the number of passengers carried. The retardation of a car on approaching a station contributes energy to the shafts which, farther on, is used in accelerating a car that is leaving the station, there being no brakes with resulting wear of wheel tires. Owing to the constant speed, no more suitable prime mover could be desired than the simple alternating-current motor. This motor requires practically no attention. It will operate with high-tension current, thereby minimizing copper in cables and entirely saving costly sub-stations and other complicated accessories to the present subway system. Transmission losses, such as are common to the ordinary third-rail systems with the sliding shoe contacts and consequent destructive earth currents, are done away with, as well as all danger of injury to the workmen or by fire in time of accident from an exposed third rail. The entire system may be mechanically considered as one vast machine under control of a single engineer at the power-house switchboard. No signal system is required, as there is absolutely no possibility of a collision except in the event of a breakdown. But the chance of a breakdown of any of the cars is exceedingly remote, owing to the fact that there are no complicated parts to become disordered, and that the axles and engaging projections can be made enormously strong. To be sure, this system is hardly adaptable to a long line, but the inventors believe that it might be applied to short crosstown lines or, by arranging the driving shafts in chords, on bridges.

In addition to this horizontal system, the Messrs. Adkins & Lewis have devised a continuous variable-speed elevator system which moves very slowly past floors, but travels swiftly between floors. A modification of this system has been devised for use at elevated and subway stations for carrying passengers to and from the street level. In this arrangement the cars move horizontally at the top and bottom of the shaft, long enough to permit passengers to step aboard or alight, and then they assume the vertical course and travel at high speed between levels.

Another application of the system is in the nature of the well-known escalator, which is becoming popular at department stores. The new design provides a series of seated cars moving slowly and horizontally in a semicircle at each floor and passing at relatively higher speed up or down an incline between all the floors.

This system is extremely flexible and can be applied in many useful ways for the transportation of passengers or merchandise.

Industrial Alcohol.*

The value and significance of a tax-free alcohol have been so widely discussed in the press and periodical literature of the entire country, that it is hardly necessary to emphasize the great importance of this subject, especially to our agricultural and industrial interests, since the new alcohol law became operative on the first of the year. For years we have been far behind the nations of Europe in this regard, and in consequence, our literature has been sadly lacking in authoritative works covering this phase of industrial activity. "Industrial Alcohol, Its Manufacture and Uses," recently issued by the publishers of the SCIENTIFIC AMERICAN, was designed with the especial purpose of supplying this want; it is the latest and most comprehensive work of its kind which has been published in this country. The book is a practical treatise, and will be found especially valuable by the layman and the student, notwithstanding that it is well adapted for use as a handbook by the expert. It comprises the researches and writings of the most eminent of Germany's specialists in the science of fermentation and distillation, being based upon Dr. Max Maercker's "Introduction to Distillation," as revised by Drs. Delbrück and Lange. The book covers the manufacture of alcohol from the raw materials to the final rectified and purified product. An introductory section deals with the importance of the new law, what it means to the farmer and the manufacturer, and the possible conditions arising under the law. In additional sections the methods of denaturing, the domestic utilization of alcohol for heating and lighting purposes, its use as a fuel for power production, and a statistical review are given. The discussion of the use of denatured alcohol for heating and lighting and for power productions is supplemented by numerous well-chosen illustrations; the entire text is fully illustrated throughout. In an Appendix is given the complete United States law. Few in number are those to whom this book would not prove of interest and value. The farmer, the manufacturer, the power producer, the householder, will all find that denatured alcohol is of importance to them, that its use and introduction will render feasible savings and economies which were hitherto impossible of accomplishment.

The Death of Prof. Ernst von Bergmann.

Prof. von Bergmann, the famous surgeon, died in Wiesbaden on March 25. He was operated on for intestinal disorder without an anæsthetic, and bore the prolonged cutting with the greatest fortitude, although he did not direct the surgery, as he did in the case of a previous operation some months ago.

Ernst von Bergmann, the celebrated German surgeon, was born in the Baltic province of Livonia on December 16, 1836. He studied at the universities of Dorpat, Vienna, and Berlin, and was graduated from the medical department of Dorpat in 1864. During the Austro-Prussian war of 1866 he was placed in charge of the military hospital at Königinhof, in Bohemia, and during the Franco-Prussian war he was at the head of the military hospitals of Mannheim and Carlsruhe. In 1875 he was appointed to the chair of surgery in the University of Dorpat, remaining there until the breaking out of the Turco-Russian war, when he became attached to the Russian army of the Danube as consulting physician. Returning to Germany, Dr. von Bergmann was made surgeon in chief of the hospital at Würzburg and professor of surgery at the university. In 1882 he was called to the chair of surgery at the University of Berlin, to succeed Prof. von Langenbeck, and also had charge of the surgical clinic of that city.

* Industrial Alcohol, Its Manufacture and Uses. A practical treatise based on Dr. Max Maercker's "Introduction to Distillation" as revised by Drs. Delbrück and Lange. Comprising Raw Materials, Malting, Mashing and Yeast Preparation, Fermentation, Distillation, Rectification and Purification of Alcohol, Alcoholometry, the Value and Significance of a Tax-Free Alcohol, Methods of Denaturing, Its Utilization for Light, Heat and Power Production, a Statistical Review, and the United States Law. By John K. Brachvogel, M. E. 528 pages, 107 engravings. Price, $4.

HOW CHURCH BELLS ARE CAST.

BY F. P. LOTZ.

Christ Church, Boston, claims to have a fine old set of bells rung in the old way as in England. I am told that they possess a very sweet tone and are among the oldest in the country. South Congregational Church, New Britain, Conn., has a magnificent set of fourteen bells, which are rung both by hand and by a combination apparatus, using electricity and compressed air in a set of pneumatics. A similar set, exclusive of pneumatics, is in the tower of St. Simeon's Church, Philadelphia, and another in Christ Church, New Haven, Conn. As fine a set of eleven bells as have ever been made are in St. John's Roman Catholic Church, Clinton, Mass. There are numerous other very fine chimes of bells in this country, among which may be mentioned those in St. Michael's Church, St. Thomas's, and St. Andrew's in New York city, and an excellent set in St. Patrick's Church, Cleveland, Ohio.

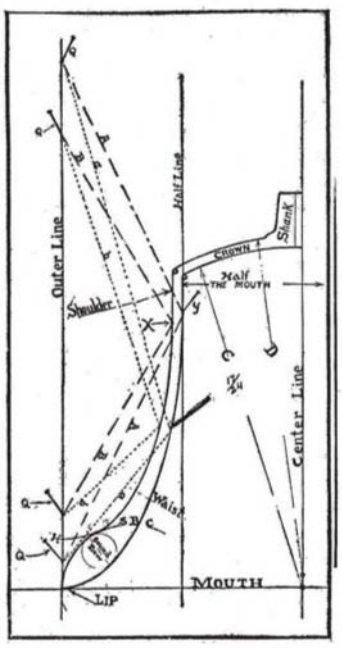


Fig. 1.—The Lay-out of the Bell on the Drafting Board.

Bells have been the subject of some of the best poems, Longfellow having written no less than nine on this subject. Among these are "The Belfry of Bruges," "The Song of the Bell," "The Bells of St. Blas," "The Bell of Atri," and "The Bells of Lynn"; and who has not heard of Poe's "The Bells," which, with his weird monody "The Raven" made his name famous? Then there are also Tennyson's poems on bells and Schiller's "Lay of the Bell."

The mechanical process of bell founding is extremely interesting to those not familiar with it. The following description of it is illustrated with photographs taken while the work was in progress in the usual every-day routine. With some modifications all founders proceed very much in the same manner, but some of the modifications mean much in the result. However, by explaining one method the whole proceeding is made very clear, and with the illustrations will, no doubt, be readily comprehended.

Having mathematically worked out the proportionate requirements and having procured a suitable pattern board, the drafting is proceeded with as shown in Fig. 1. First the center line and the mouth line are laid off, exactly at right angles. Then the half line and outer line are laid off parallel to the center line. The required measurements are then laid off and pins set in place, as shown by *Q* and *X* and *Y;* a string which cannot stretch is then adjusted along the line *A A*, the pin at *X* is removed and a pencil substituted, with which, keeping the string quite taut and carrying it downward, is thus drawn the inside or large elliptical curve down to the point of the lip, as indicated by the dotted line *a a*. In a similar way exactly the outer or small elliptical curve is drawn, shown by *B B* and carried down by the dotted line *b b*, ending at *H* and representing the string. The sound-bow is then drawn over the circle so marked, with a compass, making the line marked *S B C*. This done, there remains only a very small gap to fill up by hand or any other convenient way where the line *B B* ends at *H*. Then from the points *X* and *Y* a straight line is drawn up to the little circles at the shoulder, and from there on the crown is drawn with a trammel *C* and *D* up to the shank. It will be seen that the *inside* diameter of the bell at the shoulder is just *half* the mouth diameter. The thickness of the bell through the sound-bow is one-fourteenth of the mouth diameter; the waist thickness is half the sound-bow, and the shoulder thickness is a third of the sound-bow. The height of the bell is about eighteen times the thickness of the sound-bow.

According to this layout, two sweepboards are now fashioned, one called the "core" sweep and the other the "case" or "outer" sweep, as shown in Fig. 2; the sweepboard having the long stem is called the core sweep, the other being the case sweep. Two iron flasks are next provided, called respectively the "case" and the "core." The former is larger by an inch or two than the required finished mold, and in this the outer shape is molded. The core is an inch or two smaller than the required finished mold, and on this the inner shape is molded. A general view of the foundry (Fig. 3) shows these molds set up, the case with its wide part up and the core with its wide part down. Fig. 4 shows a molder at work near the end of the sweeping up of a core mold with the rough loam coating. Then comes the last work on the outer mold, that of slicking over just after impressing the inscription, which will appear on the bell in raised letters.

The molds are next closed and set around in order under a large crane ready for casting, and here there is a marked difference between the American and the European method. It will be noticed that these iron flasks have numerous holes which are provided for a twofold purpose—to make the loam coating adhere more thoroughly and to allow the gas which is generated during the few seconds required for the pouring to escape through these "vent" holes and burn itself out. The European method is to sweep up the molds over brick cores in a pit, and then over this to sweep a bell of clay, and over this, beginning with the smooth coat, they lay on the outer loam form. When the molds are done, they lift off the outer mold, break up the clay bell, replace the outer mold, and then pack the whole in the pit by pressing down the dirt previously excavated and then weighting it down. Nothing shows above the foundry floor level but the "heads" or "gates" for the entrance of the molten metal. There is always danger of gas explosion by the European method. By our method this danger is reduced to practically nothing, because all our casting is done practically above ground and in a way that allows the gas to burn out. The next step is that of tapping the generally well known hot-air furnace of the melted bell metal, which in a few minutes is poured into the molds in the manner shown by Fig. 5, and this view also shows how the molds are set under the big crane ready for casting, to which reference has already been made. This casting is generally done as early during the day as possible, so as to give plenty of time to allow the metal to cool slowly down by the next day, when the bells are removed from the molds and allowed to finish cooling.

If some of these bells are intended for a peal or chime, they are then lifted up and tested somewhat in the manner shown in Fig. 6, to ascertain how near to accuracy the pitch is. Generally they come pretty close to what is desired, and a little skillful mechanical tuning brings it to standard accuracy. A finished peal of four bells is shown in Fig. 7. A chime of bells appears complete and set up in Fig. 8. These are played in the tower with the lever keyboard as shown in Fig. 9. If the bell be for a tower clock or for fire alarm use, for school or church tower, used singly—i. e., not a part of a musical set—then no tuning is done to it after being cast, and this because without the tuning it has a certain individuality all its own which is very desirable, and for school or church use it is mounted in the usual way. In this position it does duty during its life, away up in the steeple, patiently though sometimes noisily, striking the hours and reminding us that Time is fleeting and soon Eternity dawns.

In the school tower the bell summons the children with heavy feet to school to garner the seeds of instruction that fit them to fill worthily our places when we are gone. In the fire alarm tower it rings its call for heroes to duty in quenching fires or in the saving of human life. And last but not least, the church bell gives softly and sweetly the call to worship.

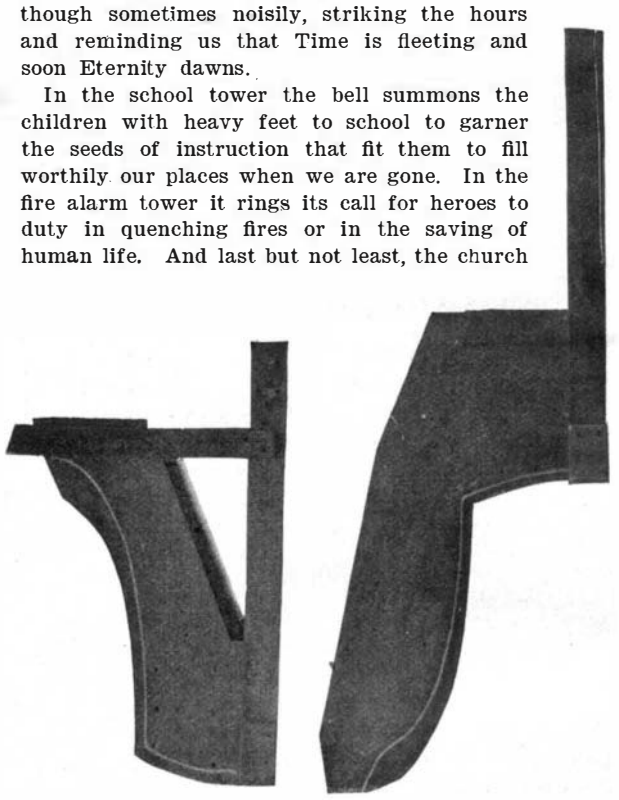


Fig. 2.—Bell Sweeps for Forming the Molds.

A Novel Storehouse.

BY W. K. FISHER.

Many mammals, chiefly rodents, store quantities of food against a season of scarcity, but it is worthy of note that very few birds have acquired the habit. In California, however, where there are long dry summers in the valleys, a shining example of thrift has been developed among the woodpeckers. This bird is the handsome California woodpecker, *Melanerpes formicivorus bairdi*, closely related to the red-headed woodpecker of the Eastern and Middle States. It is one of the most industrious creatures in California, and to the casual observer its principal occupation might seem to be the hoarding of acorns. Our woodpecker does not go about its work in the offhand, slipshod manner of the California jay, which pounds its acorns into the ground, with a guilty air, and then apparently forgets all about them. Instead, Melanerpes drills a neat round hole in the bark of a tree, and into this wedges the acorn, which fits so tightly that one has to use a pen-knife to extract it. The birds are most active during the autumn and winter, when they store many acorns for food, showing a decided preference for the slender nut of the California live oak. Whether the birds particularly desire a grub which lives in the acorn is not known, but we do know that they eat the nuts. The habit of fitting them so tightly into holes in bark may have been acquired for pro-

Fig. 3.—The Foundry, Showing Flasks and Cores.

Fig. 4.—Sweeping the Core.

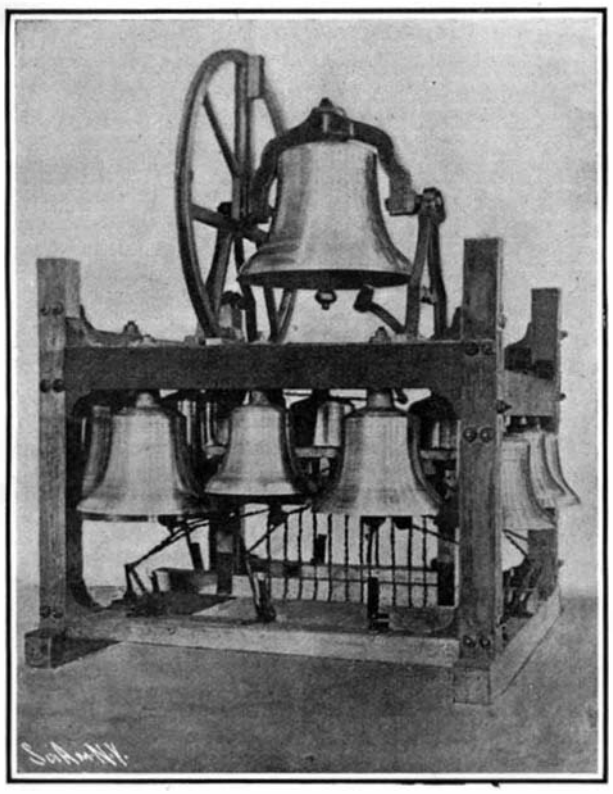


Fig. 8.—A Chime of Bells.

tection against the depredation of ground squirrels.

Although scattered acorns are found in telegraph poles, in fence posts, in the sides of houses, or wedged under shingles, the woodpeckers seem to prefer live oaks, in the valleys. In the mountains conifers are used also. Leaky roofs often result from the wedging of acorns under shingles, or from holes drilled into them; and many a rancher has been provoked to profanity by having his house perforated.

A characteristic of the woodpeckers is their fondness for certain individual trees. They store their acorns in the same tree and use the same holes year after year, adding new holes as time goes by, and the old ones wear out. A few of these trees must have a reputation among woodpeckers for miles around, judging by the way they are visited and the number of acorns deposited in their bark. Such a tree—a large live oak, now somewhat famous, at least locally—stands in front of President David Starr Jordan's residence at Stanford University, California. Its bark is closely studded with acorns, even out onto the smaller limbs. Some of them have been driven into the ends of old, partially decayed nuts, which they have telescoped, the old shell inclosing the fresh acorn. Only a portion of each acorn is eaten by the woodpeckers, many remaining till they decay, or are "driven to the wall" by the insertion of fresh nuts. After a time the bark partially decays about the old holes so that the acorns will not fit tightly. Such holes are often abandoned.

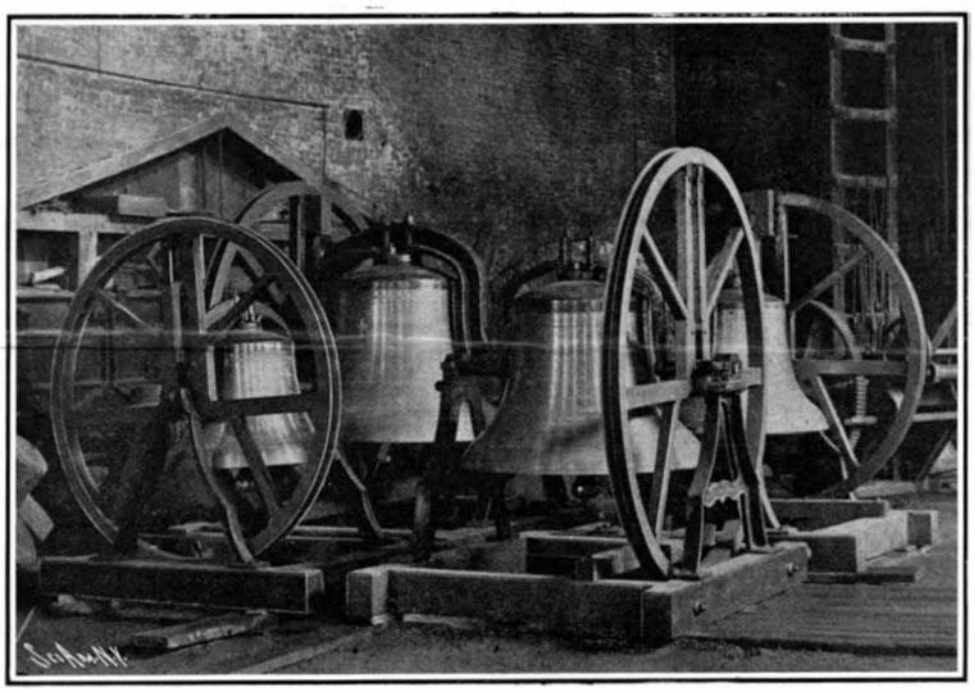


Fig. 7.—A Finished Peal of Four Bells.

A Singular Effect of Friction.

In a communication presented to the French Academy, E. Guyou comments upon some curious experiments made by De Saintignon, of which Guyou gives a brief account only. A spherical vessel is rotated about its vertical axis some eight hundred times per minute; dimensions are not given. Powdered substances are distributed in the water contained in the vessel. When the vessel is rotated, the powdered particles will arrange themselves along the axis of rotation, if they are less dense than water. But if they are heavier than water they will collect, not on the equator of the vessel, as one might expect, but on two rings corresponding to equal parallels of latitude on both sides of the equator. In explaining this apparent paradox, Guyou points out that, after a certain time, the particles will revolve with the velocity of the globe, and the effects of gravity and of centrifugal acceleration may be neglected. The resultant of the remaining forces will urge any particle in the direction of the radius of the parallel in which it finds itself. If the particle is less dense than the liquid, the resultant will be centripetal, and the particle will move toward the axis of rotation; if the particle is denser than the liquid, the particle will travel toward the wall of the vessel. Having reached the wall, the particle will be pressed against it by this radial force which is at right angles to the axis of rotation, and therefore oblique to the wall. The angle which the normal to the respective point of the wall forms with the force will be equal to what we call latitude in determining positions on our globe; we may thus speak of the latitude of the particle. If now the latitude of the particle is greater than the angle of friction between the particle and the wall corresponding to the conditions of the experiment, the particle will glide toward the equator. If, however, the latitude of the particle is smaller than the angle of friction, or equal to it, the particle will remain at the point where it met the wall. The globe may thus be imagined to be divided into three zones. The central zone will lie between the two parallels, north and south of the equator, whose latitude is equal to the angle of friction; the two other zones or segments will lie outside this equatorial belt. For the particles within the belt the latitude will be smaller than the angle of friction, and they will therefore remain in their belt; the particles outside the belt will have a greater latitude, and they will glide down to the parallel where the latitude and the angle of friction are equal to one another. Thus, with powdered charcoal, we observe two black circles of latitudes about 30 deg., limiting an equatorial belt which is turbid with black spots of charcoal, while the two polar segments will be clear. The case of coal is unfortunately the only one concerning which the brief details quoted are given. It would be interesting to have further data, and to ascertain whether friction is really the only or the chief determining factor in the phenomenon. Experiments might be made with heavy precipitates. Guyou suggests that the observed latitude should be measured for the direct determination of the angle of friction.

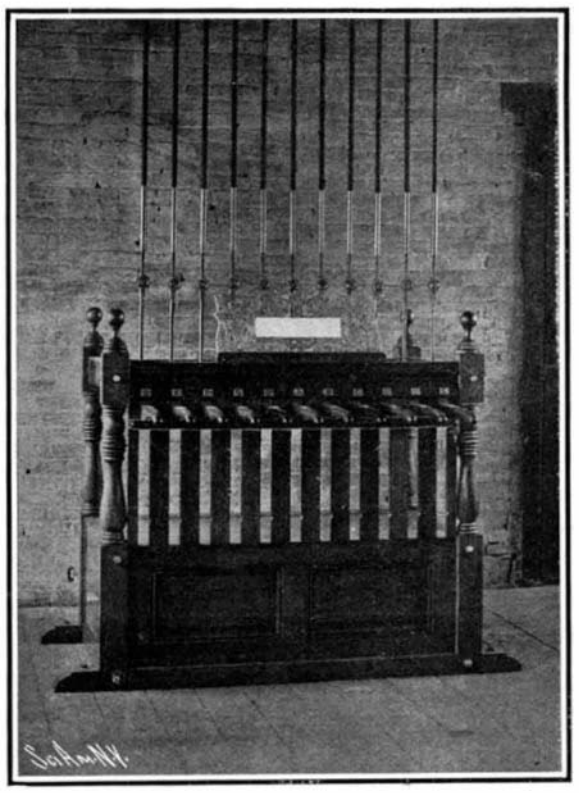


Fig. 9.—A Lever Keyboard.

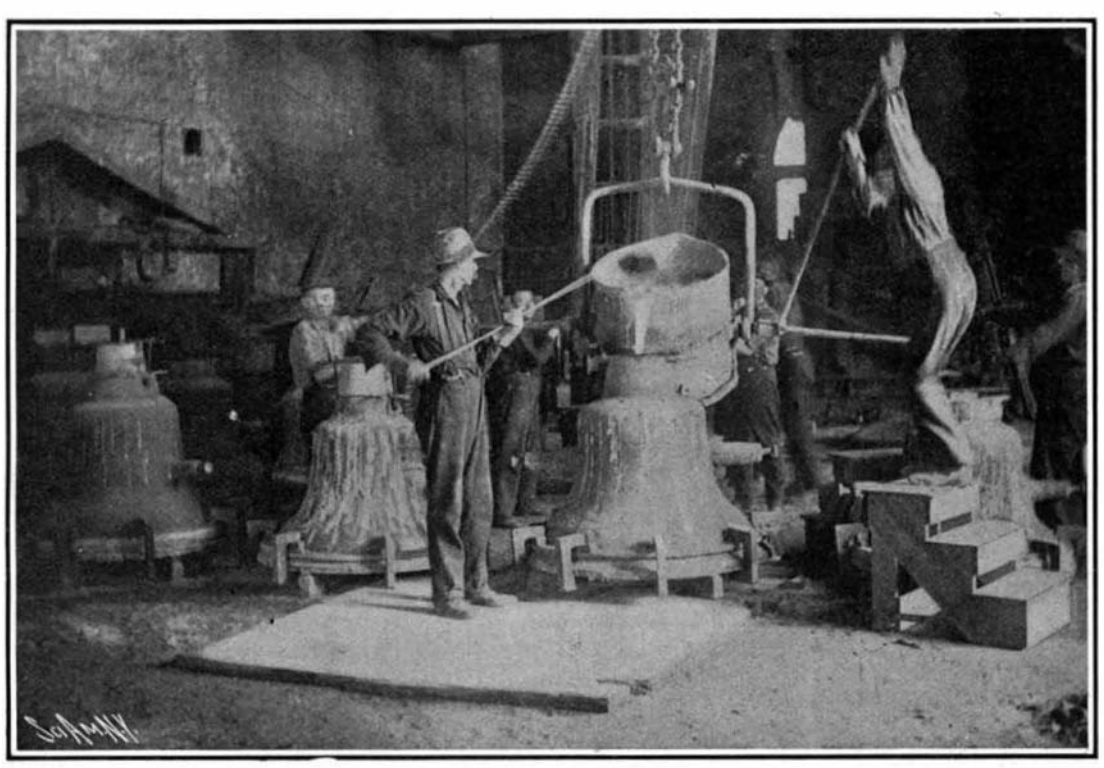


Fig. 5.—Casting the Bell.

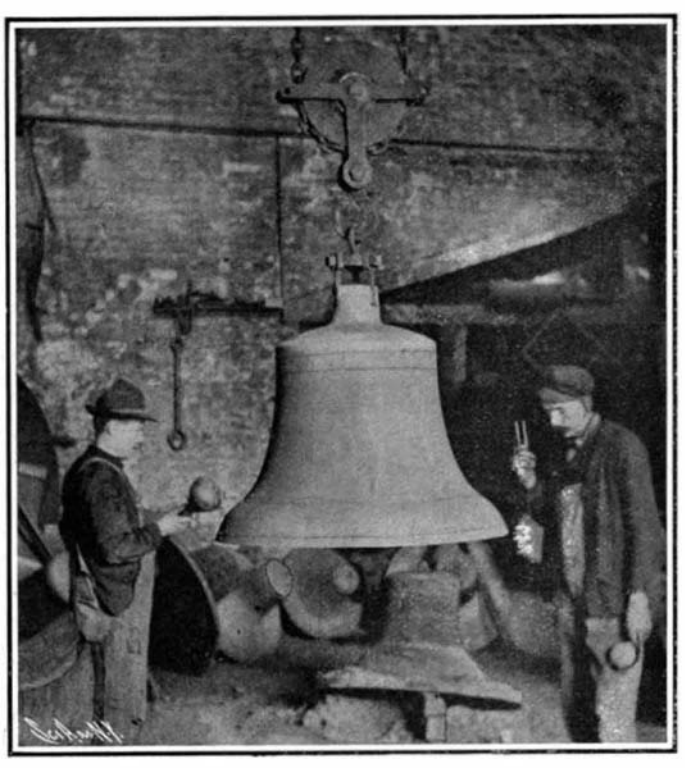


Fig. 6.—Testing the Tone of the Bell.

HOW CHURCH BELLS ARE CAST.

The X-ray is being used by pearl fishers of Ceylon to determine the presence of pearls in oysters.

A BABYLONIAN VASE INLAID WITH IVORY AND PRECIOUS STONES DATING FROM 4500 B. C.

BY PROF. E. J. BANKS, FIELD DIRECTOR OF THE RECENT BABYLONIAN EXPEDITION OF THE UNIVERSITY OF CHICAGO.

It may seem to the layman that the Assyriologist and Egyptologist are rivals in the efforts to bring to light the earliest traces of civilization, for during the past decades each has startled the world by announcing that he has discovered traces of civilized man of five, six, and even ten thousand years ago. In confirmation of his statements, he produces strange objects from the ruins of Babylonia or Egypt. Yet such extremely ancient antiquities are rare. At Bismya, the ruin in central Babylonia which, as field director of an expedition from the University of Chicago, I recently excavated, and which has proved to be the remains of the oldest known city in the world, was discovered, among other remarkable things, a blue soapstone vase richly engraved with human figures and inlaid with ivory and precious stones.

The vase, when found, was in fragments, three of which were recovered from among hundreds of fragments of vases of other stone. All were lying in an ancient refuse heap of the temple, where they had been thrown. The position of this heap of rubbish, buried beneath the ruins of structures known to date from 3800 B. C., and containing a number of inscriptions and bricks, as well as the style of art, point to a date not far from 4500 B. C. The original diameter of this vase of blue soapstone was about twenty-two centimeters (8¾ inches); the height of its nearly vertical walls was about twenty centimeters (8 inches), and the three surviving fragments represent somewhat more than a quarter of the vase.

One of the most remarkable features of the vase is that it is unlike anything ever before discovered in any ancient ruins. Upon the three fragments are represented at least thirteen human figures, either entire or partly broken away. The two central figures are musicians, who are playing upon their five and seven stringed harps as they are marching along. If for no other reason, the engraving is remarkable because it gives us the picture of the musical instrument of more than six thousand years ago. Behind the musicians marches a person of importance, possibly the king, for from his hat project three rays to distinguish him from the others in the procession. Behind him are two other figures. One, judging from his size, is a boy; the other is holding up his hands in the attitude of worship. Before and above the musicians are figures, who are represented as running to meet the procession. One man holds in his hand a branch of a tree, while other branches are scattered about among the figures. The engraving may represent one of the religious processions common in later Babylonian history, when the gods were carried about the city. Yet the running figures more likely indicate the triumphal procession of a victorious king, accompanied by music, and an occasion of great joy is represented.

Still more remarkable is the execution of the engraving. While the field of the picture is represented by the blue stone of the vase, the figures are partly composed of inlaid materials. When found, the inlay, with the exception of a few pieces of lapis-lazuli in one of the tree branches, was missing, yet the deep grooves into which it had been set remain to show where it had been. Later I discovered a square piece of ivory, which formed the skirt of the figure bearing the branch. From this one ivory dress we may infer that the dresses of all of the figures were of the same material. The faces, arms, and feet are represented in relief, and the long braids of hair and the hats are also of the stone of the vase. Judging from other objects found in the Bismya temple, it would seem that the eyes were inlaid with blue stone. The material employed to represent the bracelets and head bands and other inlaid parts cannot be known, yet from the dump small pieces of red and blue stone, mother-of-pearl, and engraved ivory appeared. Some of them may have been used in the missing parts of the vase.

A chief peculiarity of the art is that the figures are represented with enormous noses, imparting to the face the grotesque appearance of a caricature. The few specimens of early Babylonian art at hand, while representing the nose in a straight line with the forehead, fail, with the exception of a few terra-cotta statuettes, to exaggerate to such an extent. The faces of the figures are shaved; the hair is braided and hangs down behind. A hat, either with or without a band and rays and a ribbon, is worn; the rays probably distinguish the rank of the wearer. Apart from the hat, the one other piece of wearing apparel represented on the fragments of the vase is the short skirt, which is known to be the Babylonian costume of about 4,500 B. C.

This unique vase of the greatest antiquity, so different from anything previously discovered, therefore opens a new study in the history of early art; it is one of the most highly prized objects from the most ancient civilization of Mesopotamia.

TWO FRAGMENTS OF VASE INLAID WITH IVORY AND STONES FROM BISMYA DATING FROM ABOUT 4500 B. C.

SKETCH OF THE DESIGN ON THE VASE.

THE GYROSCOPE AS A COMPASS.

BY A. FREDERICK COLLINS.

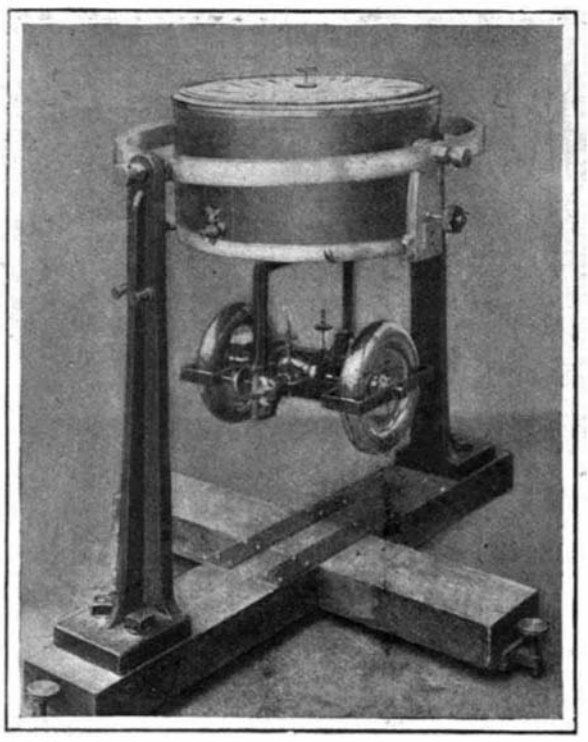
Since the invention of the gyroscope by Foucault, to demonstrate the rotation of the earth upon its axis, this mechanism has been constructed in many modified forms, and the principles underlying it have been utilized for various purposes. But it is doubtful if a more ingenious construction has ever been devised, or a more useful application been found for it, than the one herein described. The Anschütz gyroscope takes its name from the inventor, Dr. H. Anschütz-Kämpfe, and was designed for the purpose of replacing or supplementing the ship's compass, where the latter for any reason is rendered useless or inaccurate. Two models of the gyroscope have been built by a Kiel firm of instrument makers, and both of these are shown in the accompanying illustrations. The second form possesses several improvements over the earlier construction, though the general design is the same in both.

In the compass the needle assumes a fixed position under the influence of the earth's magnetic attraction, while in the gyroscope, on the other hand, there is a rotating system affixed to a horizontal axle, which can turn freely in all directions. The spindle of this device has a strong tendency to retain its momentary direction, and when the binnacle, which is an integral part of the vessel, turns with the movement of the vessel, the indicator carried by the spindle will correspondingly turn against the binnacle, or in the opposite direction. Thus the indicator will point out in degrees, or fixed lines of a scale, the variations in the course of the ship.

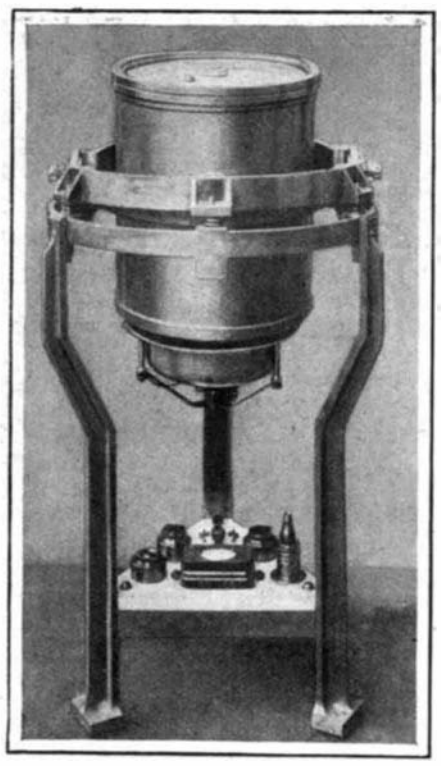
The mechanical construction of the instrument is comparatively simple, and most of the important parts can be recognized in the first illustration, where the lower cover has been removed. The strong iron bases of the binnacle carry a holder suspended in gimbals and filled with liquid. In this liquid is a float fixed to a vertical axle, on which it can revolve. The rose or compass scale is secured to the float, and is controlled by the attached gyroscopic system proper. This system consists of two balls or disks, which are driven by a motor lying between them, the current being communicated by means of brushes. The frame containing the balls and motor is attached to a horizontal axle on ball bearings, which rest on the float. The diameter of the holder is 18½ inches, while the height of the whole instrument is 35 inches. The construction of the new model differs from the old chiefly in that the system does not depend from the float, but is contained within it. The float has a capacity of about 22 quarts, and also contains a pair of electromagnets. It revolves easily on a vertical axle in the basin, and its weight on this axle is almost compensated by the supporting power of the liquid. The basin is hung in gimbals to a strong metal ring, which rests on springs attached to the stand. The latter is three-legged, and is made of bronze. Between the three legs is a small marble shelf, which contains the measuring instruments, ruler, etc. The dimensions of the new form of apparatus are approximately: height 43 inches, diameter of basin 14 inches, and the largest diameter 23½ inches. An improvement consists in a small motor with a perpendicular axle, upon which a bell-shaped balance is placed. The bell-shaped balance is seen below the cylindrical holder in the second engraving. This motor is started simultaneously with the system, and attains a velocity of 3,000 revolutions per minute. Its purpose is to retain the basin in a perpendicular position by means of its rotary force, or at least to permit only slow and slight movements, thus considerably increasing the efficiency of the apparatus. In both instruments the gyroscopic system rotates at the rate of 3,000 revolutions per minute.

Both the compass and the gyroscope possess disadvantages as well as advantages, but fortunately one instrument appears practically to supplement the other. The compass is not subject to certain untoward influences which are liable to affect the gyroscope, because of fundamental differences in action. The compass needle under the magnetic action of the earth assumes one fixed position. The gyroscope, on the other hand, tends persistently to maintain any position in which it is placed, until acted upon by other forces. Obviously, there are opportunities for error to slip into calculations based upon this apparatus, particularly after it has been in use for some time without resetting, and it consequently appears that occasional adjusting would be necessary. Owing to the revolution of the earth upon its axis, the gyroscope's spindle would have an additional gradual movement of rotation, and the rate of this movement would depend on the latitudinal position of the ship. It is interesting to note that this movement would amount to one degree in four minutes at the north pole. The spherical form of the earth also influences the instrument, and in consequence the gyroscope would turn slowly toward the course of the vessel, in accordance with its longitudinal position. The compass, however, is practically unaffected by latitude or longitude.

The disadvantages of the compass may be briefly summed up in saying that it is strongly affected by shocks, vibrations, moving masses of steel or iron, or even by unequally distributed, fixed masses of metal, while the gyroscope is influenced in no way whatsoever by these considerations. The deviations of the compass needle due to the above causes have been only partially overcome by systems of compensation. It is of course impossible to obviate the disturbing causes mentioned, especially in the case of war vessels. Here the compass is often rendered erratic by high speed under forced draft, particularly in torpedo boats, by swinging davits, cranes, guns, or turrets, and by the concussions due to gun discharges. In submarine work the compass is often almost use-



Anschütz Gyroscope. First Model.



Anschütz Gyroscope. Final Form.

THE GYROSCOPE AS A COMPASS.

less because of the close association of masses of metal. Further, when the course of a vessel is changed, the compass will not indicate with absolute accuracy the turning movement, and to all other disturbing factors we must add the friction offered to the indicator or rose in liquid compasses. It is under such circumstances that the gyroscope has proven itself an effectual means for checking compass readings, and in some cases even as a substitute for that instrument, for it is absolutely unaffected by influences derogatory to the other.

The greatest difficulty experienced by the inventor was in attempting to rectify that characteristic of the gyroscope which varied the movements of the rotating element in accordance with the longitudinal position of the ship. This was finally accomplished by the introduction of a pair of electro-magnets, mentioned above, into the holder, thus in a measure converting the instrument into a magnetic compass, or rather into a combination of gyroscope and compass. With this improvement the rose can be set to a certain course, and the vessel then steered as by an ordinary compass.

Exhaustive tests were made by the German navy with the warship "Undine," which was fitted with the instrument for this purpose. Some of the evolutions, which consisted in sailing the ship under forced draft and then suddenly reversing the engines, changing the position of the turrets and other heavy mechanism, and in firing the guns, were severe enough to completely disqualify the magnetic compass. However, when the trials were concluded the gyroscope was found to be in as good order as it was in the beginning. The opinion has been strongly expressed by observers that these tests thoroughly demonstrated the efficiency of the gyroscope as an aid to navigation.

A PERIPATETIC LECTURE ROOM; WESTERN FARMERS ATTENDING AN AGRICULTURAL LECTURE IN A RAILROAD CAR.

AN UNSINKABLE MOTOR LIFEBOAT.

BY L. RAMAKERS.

A series of experiments of great interest alike to engineers, to sportsmen, and to life-saving societies took place recently on the Thames, near London.

For the past two or three years the Royal National Lifeboat Institution has been endeavoring to stimulate the activity of English inventors and boat builders by calling for improved types of lifeboats, for the reason that the boats now in use do not always meet the demands made upon them by the bravery and devotion of the life-savers.

After the seaworthiness of motor boats had been proved in various contests in French and English waters, the Institution published a precise statement of its "desiderata." It demanded a lifeboat propelled by a motor that would not be affected by the waves or entirely disabled even if the boat were capsized.

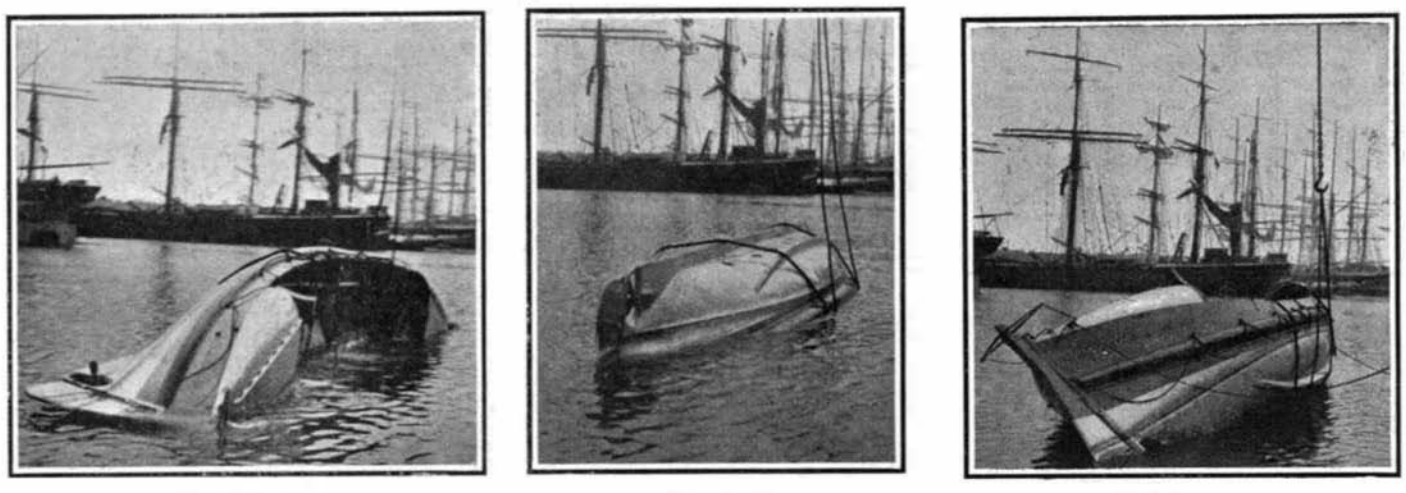
This interesting problem has now been solved by the well-known constructors of seagoing torpedo boats and steam yachts, Messrs. John I. Thornycroft & Co., of Chiswick, England. The completion of their new lifeboat, the "Michael Henry," which is shown in the accompanying illustrations, marks an era in the annals of naval construction. In appearance it differs little from an ordinary lifeboat, propelled by oars, for which it would be taken at a little distance. As a matter of fact it is propelled both by oars and by a 24-horse-power, four-cylinder gasoline motor, which is placed amidships and near the keel so that it does not interfere with the movements of the rowers.

The boat was subjected to various tests in the presence of the officers of the Institution and a representative of the Admiralty. In the trials of speed and stability the "Michael Henry," carrying all its accessories in addition to sandbags equal in weight to a crew of seven men, attained the calculated speed, 7.3 knots, when driven by its motor and propeller.

The speed trial was followed by more interesting experiments, the object of which was to show that the casing surrounding the gasoline motor was perfectly watertight and, especially, to prove that the motor would stop automatically, as required by the Royal National Lifeboat Institution, if the boat should turn completely over and float with its keel in the air. It is scarcely necessary to insist upon the importance of this point, as it will be readily understood that a propeller that should continue to revolve after such an accident would be likely to wound or even kill some of the passengers and crew. Besides, the propeller would be liable to damage by fouling with cordage.

The results of these experiments were completely satisfactory. With the aid of tackle attached to the yard of a ship the "Michael Henry" was first thrown on her beam ends and then completely capsized, as illustrated by the photographs. At the beginning of the operation, that is to say, when the boat began to heel over, the motor, which had just been started at full speed, stopped automatically. It also started automatically when the boat returned to its normal position. The experiment was repeated several times with the same result.

The new type, therefore, represents a real improvement and appears destined to render very great service in navigation and especially in the saving of life.



On Her Beam Ends. Bottom Up. Careened.

CAPSIZING THE UNSINKABLE MOTOR BOAT "MICHAEL HENRY."

A LECTURE ROOM ON A RAILROAD TRAIN.

BY KATHERINE LOUISE SMITH.

For the past two years certain Western railroads have sent out so-called "Good Seed Trains" to assist the farmer in his vocation. Early in the year the trains are started, and through the spring months farmers have free rides and lectures galore until the spring break-up renders it necessary for them to devote their time to the land. These trains are fully equipped for the lecturer and his farmer audience. They pass slowly from village to village, can be flagged anywhere between stations if enough farmers are collected to warrant it, and often stop at some small place long enough for the lecturer to explain the object of the train and to give sometimes a talk on seeds and seed planting. In fact, these trains are among the most interesting of the efforts made by the large railroads to help the farmers along their lines. Usually, the lecturer is a professor from some agricultural college. He stands in one end of the car beside a large chart illustrative of the work, and lectures on such subjects as rotation of crops, seed germination, condition of crops along the line, remedies for defects, the yield to the acre, etc. The cars are always filled with farmers who are appreciative of a chance to get a ride and lecture free. Great interest is taken in the theories advanced by the speaker, and often questions are asked and experiences exchanged. The varieties of wheat or coarse grains raised in the vicinity of a town, the peculiarities of the soil, and the good or bad crops of farmers in the vicinity are topics always discussed. The lecturer, besides covering the general subject of good seed, dwells upon adverse influences that may have been shown in the crops of a county or township, so that farmers desiring information as to the peculiarities of the land may obtain it. The bulletins of the various agricultural stations are distributed generously.

The lectures, whether in hall, station, or car, are well attended. Often a car is so crowded that men sit in the aisle, and some roads plan a stop of forty-five minutes to one hour at a station, so the lecture can be delivered while the car is sidetracked. When a train is scheduled to be at a certain place at a certain hour, the farmers sometimes engage a hall and try to make arrangements for the lecturer to talk there and use his charts or stereopticon. The latest move among the most progressive western roads, like the Chicago, Milwaukee & St. Paul, the Chicago & Northwestern, and "The Soo," which traverse the vast farm lands of Wisconsin, Minnesota, and the Dakotas, is to start this train in winter. The farmers in this way gain the needed information before the time of seeding and when they are not so driven with work. While the attendance is large in the spring months, more farmers can attend in winter, and they have more leisure to discuss the important matters presented and to make their plans for ultimate scientific results.

The general superintendents of the roads are much interested in the "Good Seed" proposition, and further the movement in every way, co-operating with the lecturers and scheduling the towns for the stops. This movement is an entirely different one from the various seed trains which have been sent out by farmers' associations to show the crops that can be raised in their district. While seeds are carried, and specimens of the fruit and vegetable family, this is by no means an exhibit car.

The "Grassland," which is one of the most novel exhibit cars going through the country, is switched from one road to another, and reminds one of a harvest field. Shocks of wheat, oats, and buckwheat are arranged in the center of the car, and apples and other fruits, potatoes, pumpkins, corn, turnips, carrots, in fact everything known to the root family, are exhibited. The sides of the car are also decorated with photographs. There are hunting scenes, camp scenes showing the once-timbered lands, fishing scenes, and views of sheep ranches, stock farms, and comfortable farm buildings.

The "Good Seed Train" is far too practical for this. All available space is needed for the numerous audience. Naturally, the train runs over a wide stretch of territory, and the far-seeing road which furnishes it reaps returns in the prosperity of the farmers along its right of way. In some sections special attention is called to the new durum macaroni wheat. This

durum wheat proposition has been pushed in the Northwest for about three years. The large millers have fought it, but others have been convinced that if this wheat would grow in the so-called semi-arid sections the productivity of the Northwest would be increased, and the chances for new wealth would be larger every year and land values rendered more stable.

As a matter of fact, the macaroni wheat controversy has been a feature of the grain trade. Secretary Wilson and Mr. Carlton, of the Department of Agriculture, have encouraged the farmers to grow it, and gradually it is being more generally introduced, so that farmers who are seeding it have made money. The acreage each year is larger than the year before, and prices increase. This wheat contains more gluten than that ordinarily used for flour.

Another subject that is claiming the attention of Western railroads is that of good dirt roads. If the farmer has difficulty in hauling his grain to the cars, the roads may well be interested and try to rectify matters. A year ago the editor of a large farm magazine suggested to some of the principal roads that they run "Good Road Trains" similar to the "Good Seed Trains," and engage a man to lecture on good roads. The result was that trains of this description were run through Iowa and neighboring States for a month. Meetings were held in many cities, and prizes were offered to farmers who could make the best road with a split-log drag.

The success of this "Good Roads Car" has been so gratifying, that one road has issued complete directions how to make and use these split-log drags, which are simply an arrangement of two logs seven to nine feet long and ten to twelve inches in diameter. These are set on edge thirty inches apart, and fastened with three strong pins wedged firmly in. A chain runs through the center of the front log at the right end and over the left end of the same log. This is hitched to the horses, and the driver stands on a movable platform placed on the logs. The whole thing is remarkably simple, and is taken off the train at stations where roads are particularly bad and a demonstration is made. Telephone poles are remarkably good to make these drags, and they are so cheap that every farmer can make one at a minimum outlay of time and expense.

Few realize the interdependence of business and railroads. Country towns exist to supply the needs of the farmer, and their prosperity is gaged by the crops of the latter. There is little profit to the merchant, the miller, the lumberman, the bank, if the farmer's crops fail or if he has to combat with poor roads to get his produce to the shipping point. Railroads realize that traffic along their lines, both passenger and freight, depends on the prosperity of the farmer. When the crops are good, cars and crews are in demand, and the wide-awake roads which are preaching the "Good Seed Gospel" and "Good Roads Movement" are profiting in more ways than one. All through the Mississippi Valley the farmers in the corn and grain countries are eagerly availing themselves of these opportunities to improve the character of the land, and the chances are that the educational trains already in vogue will be supplemented by others as occasion demands.

Fig. 2.—Part of the First Section Passing Through the Forest.

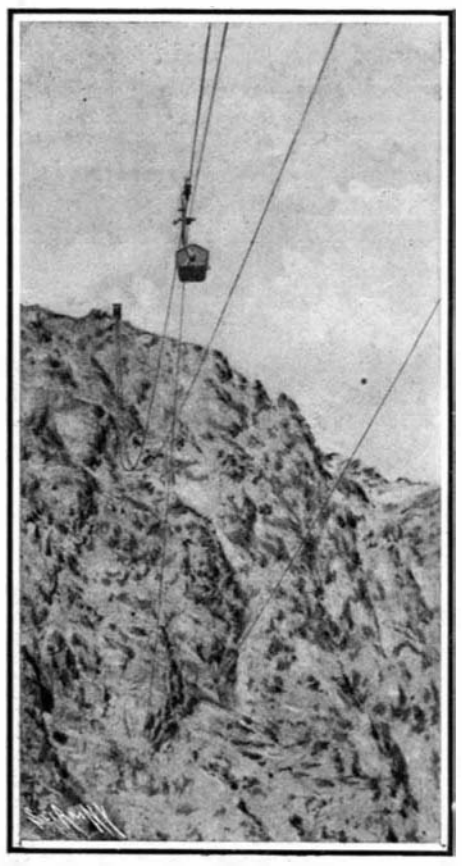


Fig. 3.—View of the Second Span, Showing the Double Support in the Distance.

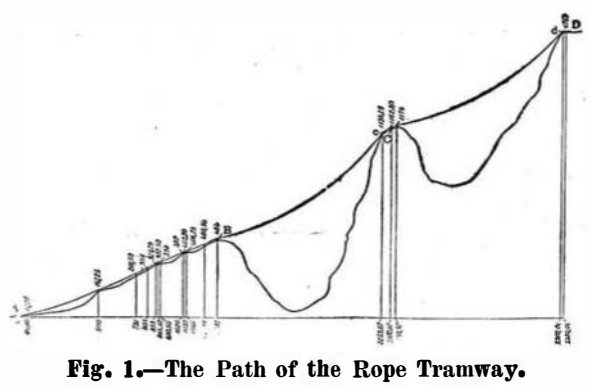


Fig. 1.—The Path of the Rope Tramway.

A WIRE ROPE RAILWAY USED IN THE CONSTRUCTION OF AN ITALIAN FORTRESS.

BY DR. ALFRED GRADENWITZ.

The ropeway described in this article was constructed by Messrs. Ceretti & Tanfani, of Milan, Italy, for use in the construction of a fortress. It is remarkable for its enormous spans and for the extraordinary altitude it reaches. The plant belongs to the Cesana Community, in the Cottian Alps, and passes between Briançon and Oulx at the foot of Mont Genèvre. The construction of this ropeway, which at present serves for the transport of all sorts of building materials required in the construction of one of the largest Italian Alpine fortresses, was supervised by the Italian engineering corps. When the fortress is completed the plant will be used for the transport of gun parts, ammunition, and rations for the garrison. Designed on the three-rope continual-operation system, the ropeway is provided with two separate runways, one of which serves for the incoming filled cars and the other for the return of the empty cars, while the third, used as a hauling rope, is situated beneath the two runways and operates the railway.

The runways are constituted by two carrying ropes, located at the same height, 7.7 feet distance from each other, and anchored in each of the stations. The runways are held taut by freely suspended weights which are connected to the carrying ropes by means of flexible ropes running over rollers. The uniform tension thus produced avoids the possibility of an overload and results in a safe compensation of any difference in tension, due to changes in temperature. The total length of the ropeway, which comprises three sections, is about 25 miles, the difference in level being 5,984 feet. Two intermediary tightening stations are provided for tension devices and anchorages for the carrying ropes.

The lowermost section starts at Cesana Station at 4,510 feet above the sea level (see *A*, Fig. 1) and leads as far as the first intermediary tension device (*B*, Fig. 1) at 6,097 feet altitude. Between these two sta-

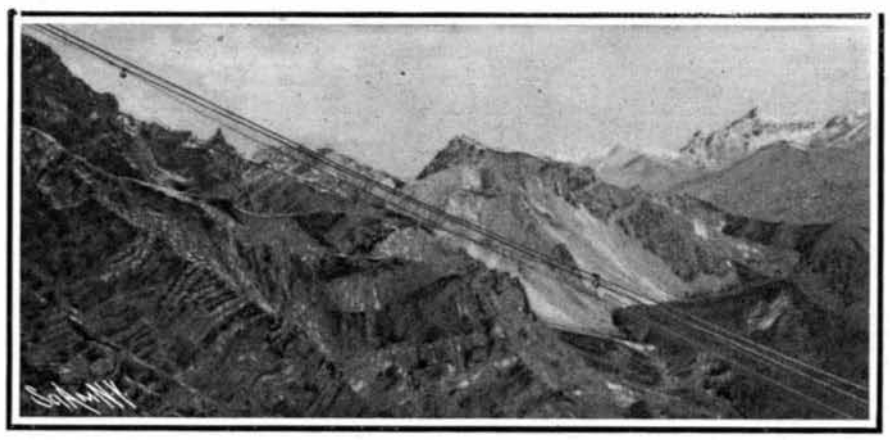


Fig. 4.—Part of the Second Span.

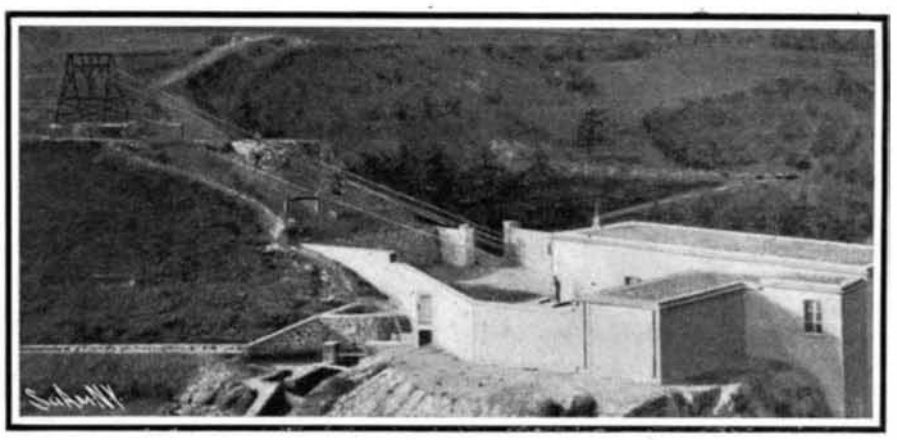


Fig. 6.—The Driving and Loading Station.

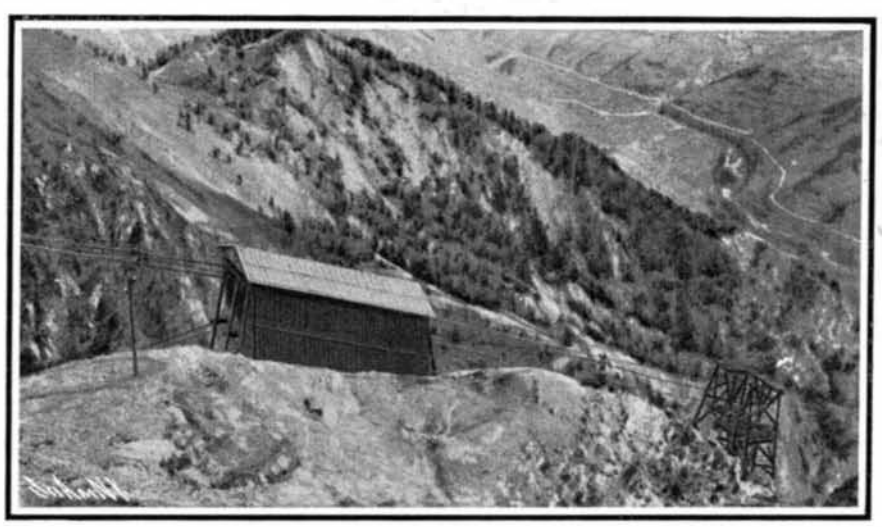


Fig. 5.—The Second Intermediary Tension Device and the Double Support in Front of It.

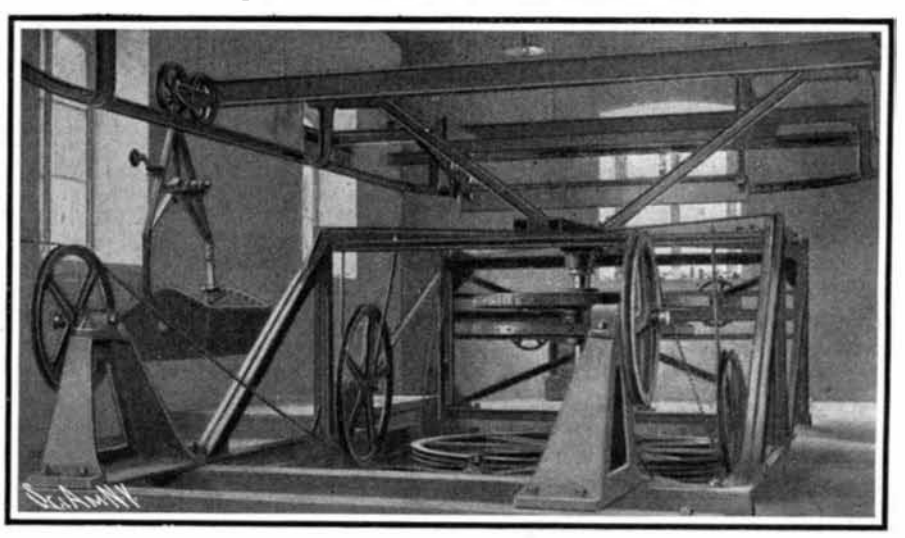


Fig. 7.—The Driving Gear.

tions there are eleven wooden piers with a maximum distance of 1,312 feet.

In Fig. 2 is shown part of the first section, the ropeway traversing the thick woods. A spirally wound rope, one inch in diameter, made from first-class case-hardened steel wire and having 95 tons breaking strength per square inch, supports the loaded buckets, while a similar rope of the same quality and of ¾ inch diameter has been provided for the emptied buckets. Both of these ropes are anchored at the first intermediary station with their tension weights in the lower motor station. In order to avoid any sliding of the traction rope in the 1,312-foot span (Fig. 1), wooden supports have been provided, carrying cast-iron guiding rollers. From the first intermediary tension device, *B*, the ropes are carried as far as the second tension device by a single double support, *c*, situated not far from the second station, *C*, so as to obtain a span of 4,100-foot length with 2,296 feet level difference. On this span of the railway two different views are represented in Figs. 2 and 3. The second intermediary tension device, *C*, with the double support, *c*, located in front of it, is shown in Fig. 5. The supporting ropes of this section are 1.12 inches and 0.8 inch in diameter.

Another large span of 7,380 feet length, overcoming another 1,968-foot level difference, will be found on the third section, where supports, *d*, have likewise been arranged shortly before the two stations, *D*, to insure the same satisfactory guiding of the rope. The supporting ropes are 1.12 inches and 1 inch in diameter respectively, and are anchored at the unloading station situated at 10,496 feet above the level of the sea, whereas the tension weights are arranged in the second intermediary station. As the various lengths of rope vary between 1,205.6 and 1,476 feet, their ends have been provided with couplings, which are filled with cast metal and which have a far higher breaking point than the rope itself, thus avoiding a loosening of the couplings.

The unloading station at Chaberton (*D* in Fig. 1), which is situated at 10,496 feet above the level of the sea and therefore covered with snow during the greater part of the year, is a structure built almost entirely of wood. The carrying ropes of the third section are anchored by means of railway rails in the foundations, and are thus perfectly isolated from the wooden discharging structure. The transition from the ropes to the station is effected by means of a steel tongue, to which are connected the suspended railway rails of the station, serving to transfer the arriving unloaded trucks to the empty rope. For the suspension of these rails there have been arranged so-called suspension shoes, which are fixed to the wooden structure at 6 to 10 feet distance. On entering the station the truck is automatically unlatched from the continually moving hauling rope and after being unloaded by the operator is conveyed to the other end of the rail, there again to be automatically coupled to the hauling rope.

The two intermediary tension devices serve for carrying the tightened and moored ropes by means of suspension rails, effecting by the aid of tongues a connection between the rope and rail. These rails have the same gage as the two carrying ropes, so that the trucks are allowed to pass over the rails without being loosened from the hauling rope, thus doing away with the necessity of any superintendence in such stations.

The tension weights above referred to, which tighten the ropes of the second and third sections, are loaded to one-fifth of the aggregate breaking strength of the rope, warranting in the latter a five-fold safety against breaking.

The driving and loading station (Fig. 6) is designed entirely of cement masonry, being connected with the 80-horse-power turbine plant which serves for the operation of both the wire-rope railway and the electric lighting dynamo. The trucks are here also automatically disengaged from the hauling rope and again coupled to it. The station is provided with a suspended railway serving for the passage and loading of the empty trucks.

The driving gear, as seen from Fig. 7 (showing an internal view of the station), comprises a main driving sheave with two leather-lined grooves, several intermediary sheaves and the sledge sheave of 6.56 feet diameter. The drive is transmitted from the turbine shaft by means of a belt disk and conical wheel gearing to the vertical shaft, to which the main rope disks are fixed. For stopping the ropeway there have been provided two wood-lined brakes.

The ropeway is engaged and disengaged by means of a clutch mounted on a turbine shaft. Beneath the floor has been arranged the sledge for the hauling rope which, owing to its length, has been designed as three-groove tackle with disks of 6.56 feet diameter. The traction rope, which is made from the best, highly flexible, case-hardened steel wire of 120 tons breaking strength per square inch, is ¾ inch in diameter and is stretched to one-tenth of this breaking strength. The speed of the hauling rope varies between 5 and 7 feet per second, the distance of the trucks being about 1,575 feet. As the latter arrive at intervals of 240 seconds, the output of the plant will be 13,000 pounds per hour, the capacity of each truck being 880 pounds. The motive force yielded by the turbine is about 55 horse-power, only eight men being required to operate the arriving and starting trucks.

The mean gradient of the railway is 50 per cent, while gradients of up to 100 per cent or 1 in 1 as occurring in some parts, are dealt with with the same safety.

The Failure of Santos Dumont's New Aeroplane.

Santos Dumont tested his new aeroplane on the parade grounds at St. Cyr on March 27, with the result that this latest and most fragile flying machine was smashed beyond repair, and was afterward cut to pieces with a saw. Two runs were made across the field. In the first one, a speed of but 12 miles an hour was obtained. In the second, the speed was perceptibly greater, but after the machine had covered half the length of the field it struck a rough spot and broke in two. The accident was apparently the result of insufficient bracing of the planes. These, as can be seen from a glance at the photographs in our last issue, were set at a wide dihedral angle without any bracing whatever. M. Dumont signified his intention of building a third aeroplane soon, and of using better material in it. In the meantime he expects to experiment further with his old machine, "14 bis," with which, it will be remembered, he flew successfully last autumn.

In a paper on the "Installation of Centrifugal Pumps," by Mr. W. O. Webber, the author states that it is safe to say that 65 per cent represents the average commercial efficiency of the multiple-stage turbine pump in the market to-day, while 80 per cent can be realized upon the straight, single-impeller, volute, centrifugal pump at heads of less than 100 feet.

RECENTLY PATENTED INVENTIONS.

Electrical Devices.

TELEPHONE-RECEIVER.—L. STEINBERGER, New York, N. Y. The several objects of the invention are to provide the receiver with a casing of metal; to provide telephone receivers or similar devices in which the magnet and other parts—such as binding-posts, binding-post sockets, and the suspending-hook—are imbedded in an insulating material which forms a core that is received in an outer case, and finally to intensify the sound-waves reproduced by the receiver.

ALTERNATING-CURRENT PLANT COMBINED WITH STORAGE BATTERY. — L. SCHRÖDER and A. MÜLLER, 31A Luisenstrasse, Berlin, Germany. The invention relates to alternating-current plants combined with storage batteries, and has the purpose to regulate the charging and discharging of the storage battery in such a manner that if the current used in the plant varies the prime mover actuating the main generator continues working with constant load. The application is for a division of the pending application formerly filed by these inventors.

ELECTRIC SIGNAL SYSTEM. — E. CHOUTEAU, JR., St. Louis, Mo. The invention relates to electric railway-signals, the more particular object being to produce a system which is to a certain extent automatic and to a certain extent is controlled at will. By means of the arrangement the engineer's mind is kept constantly trained, so that vigilance becomes habitual and there is no relapsing into the habit of carelessness.

Of Interest to Farmers.

CORN AND BRUSH KNIFE.—D. B. DATE and A. B. KUGELMANN, New York, N. Y. One of the purposes of this improvement is to provide a construction of corn and brush knife whereby labor will be much reduced and which will cut simultaneously and equally at both sides of the slanting stalks and brush, producing a clean shear cut having an upward inclination.

CULTIVATOR. — A. M. BARKER, Franklin, Neb. This invention relates to straddle-row cultivators, and has for its object the provision of means effective in operation, and durable in use adapted to cultivate one or more rows of plants, as may be desired. Means are provided enabling the gang-beams to be adjusted at the desired distance apart.

Of General Interest.

WINDOW-SHADE ADJUSTER.—NELLIE F. CAPPS, Red Bluff, Cal. This invention introduces a new feature in shade adjusters, enabling the operator to raise or lower the shade, admitting air and light as desirable in offices, or to bring out the shade transversely from the window casing, to swing it to right or left to admit air and shut out rays of light, as is especially desirable in sleeping rooms in hot weather. It is very simple, requires no fitting, is easy to put up, does what is claimed for it, and can be cheaply manufactured.

DIVISION-PLATE FOR EGG-CASES.—C. J. VOORHORST, Chicago, Ill. The invention is an improvement in pocketed packing-plates for use in holding eggs, fruit, or other articles during transportation or storage. The plates when made of paper-pulp or similar material will be comparatively rigid as to their egg-receiving units or pockets and somewhat flexible as to the lines along the curve-reversing line, so it will possess the strength of the dome or arch in the pockets to protect the eggs and also the desired flexibility to permit its adjustment or yielding when in use.

PAINT.—J. F. VILLARD, Rexton, New Brunswick, Canada. In this composition of matter adapted for use as a paint the ingredients are so united that they will remain homogeneous and in it the oil will not separate from the other ingredients even when the paint is left standing in the cans. This paint will not prematurely run and drop from the brush.

TRUCK FOR WOOD-PRESERVING RETORTS.—H. M. ROLLINS and A. J. NEFF, Houston, Texas. The principal object of the invention is to so construct a truck as to permit the loading of a greater amount of wood upon it than has heretofore been the case, and especially to provide for filling practically the entire space with a retort with wood or other articles to be treated. A further object is to provide for preventing the lifting of the truck when the liquid preservative is introduced into the retort.

CASK OR VESSEL FROM WHICH LIQUID IS DISCHARGED UNDER PRESSURE.—G. LINDNER, 88 Kriegstrasse, Karlsruhe, Baden, Germany. The object of the invention is to cause the vessel to operate with expansion of compressed air in order to fully utilize the energy of the compressed air, to effect economy in driving power. For this purpose two floats are employed. This air enters the vessel with a higher pressure than is necessary. In consequence the air-pressure at the commencement accelerates the motion of the liquid and maintains rapid current. The vessel emptied to a certain extent, one float closes the air-supply. Compressed air now operates in further expelling the liquid until pressure has sunk correspondingly to pressure of the liquid-column. This attained, the second float opens the air-discharge.

PIANO SOUNDING-BOARD. — THEODORE WOLFRAM, Columbus, Ohio. Mr. Wolfram's sounding-board is formed with a continuous rib spaced a uniform distance from the inner contour of the back frame. The usual transverse ribs are secured to the face of the sounding-board within the continuous rib. By this arrangement that portion of the sounding-board lying outside of the continuous rib is wholly unobstructed, so that the sounding-board is rendered exceedingly sensitive to vibrations. Every part of the sounding-board is in sympathy and weak places in the scale are prevented. In general, the tone is richer, and a very superior sustaining quality is obtained.

Hardware.

CULINARY TONGS.—C. F. SMITH, New York, N. Y. The tongs are for use in grasping and lifting such articles as eggs, potatoes, and the like. They are composed of a single wire bent upon itself at its center to form arms, connected together by an eye, which serves as a spring tending to hold the arms in separated relation. At the end of each arm a pocket is provided of like construction, these pockets being formed by spirally coiling the wire conically and in an oval shape, thus adapting the pockets for grasping and lifting the above-named articles.

Machines and Mechanical Devices.

PAPER-MAKING MACHINE.—J. B. WALKER and A. R. BOND, New York, N. Y. The invention relates to paper-making machines, particularly of the type known to the art as "cylinder-machines." The fibers of paper ordinarily made have a general trend or grain in the direction of the length of the paper, mainly due to the fact that the fibers deposited on the screen are dragged through the pulp in the tank as the cylinder revolves and are virtually combed in the direction of rotation. By means of the invention, a paper is produced with a grain running transversely to the length of the paper.

MACHINE FOR CUTTING WEB MATERIALS.—W. D. SKIDMORE, Pelham, N. Y. A carriage reciprocates along the line of movement of paper or other stock and is actuated by a cam device to move with and in direction of the stock during cutting operation. Stock cutting is effected by ledger and shear blades mounted on the carriage, the latter blade being periodically advanced to cut by a tappet mechanism geared to work in time with the movements of the stock and carriage. From the knives the cut stock is received by a set of delivery-rolls which deliver from the machine. These rolls may also be made to crease edges of cut material so that each length will preserve its direction until clear of the machine, to make room for the succeeding length.

PISTOL.—M. J. SHIMER, Freemansburg, Pa. The frame mechanism consists of but two main elements, the trigger and hammer and accompanying springs. The trigger automatically follows the hammer to cocked position and acts as a sear to hold it cocked until the trigger is pulled. The principal purpose of the inventor is to provide means whereby when the barrel is broken or opened to introduce a cartridge the hammer will be automatically locked in full cocked position and the trigger will be held stationary until the barrel is restored to normal position.

SAW-SHARPENING MACHINE. — J. D. MCAULAY, Baddeck, Nova Scotia, Canada. The machine comprises means for carrying the saw and actuating devices for moving the saw to bring the teeth thereof successively into proper position to be sharpened. Reciprocating sharpening devices are used, together with a guide therefor, in association with a horizontally-shiftable supporting-frame for said guide, the organization being such that the sharpening devices proper may be quickly shifted and set to different positions relatively to the stand for enabling the sharpening to be effected.

FILLING-FINGER.—W. E. LYFORD, Thompsonville, Conn. The invention pertains to yarn-printing machines, such as are used by carpet manufacturers in making tapestry and other carpets, rugs, and the like. The object is to provide a finger for guiding yarn onto the printing-drum, and arranged to smooth the yarn on the drum, thereby insuring a proper uniform application of the color onto the yarn during the subsequent usual process of printing.

AIR-COMPRESSOR.—A. GOOD, Claflin, Kan. The invention has reference to cylinders and valve mechanism suitable for use as an air compressor or as an engine. In operation the device may be used for withdrawing an aeriform body through a pipe leading to any desired point—say to the bottom of a mine and expelling the body through a hand-valve. The device is used in this way for the purpose of removing choke-damp and noxious gases from mines and causing the latter to be filled with fresh and pure air.

ADDING-MACHINE.—A. I. GANCHER, New York, N. Y., and A. T. ZABRISKIE, Passaic, N. J. The object of the present invention is to provide a machine arranged to render the action of the number-wheels positive and without danger of the parts easily getting out of order and to allow convenient and quick resetting of the machine to zero when desired. It relates to adding-machines, such as shown and described in Letters Patent of the United States formerly granted to N. H. Kodama and A. I. Gancher.

BOOKBINDING-MACHINE.—W. E. BLAUVELT, New York, N. Y. The invention relates to improvements in machines for affixing the crash, the head-bands and the paper lining to books preparatory to placing the covers thereon, an object being to provide a machine of this character by means of which the work

may be rapidly carried on and the books delivered from the machine in a strong and neatly finished condition. The general plan is shown in the patent formerly granted to Mr. Blauvelt.

ATTACHMENT FOR CLEANING COTTON-GIN SAWS.—H. J. Fitzpatrick, Athens, Ga. Gin-saws must always be dry, and in ginning wet or green cotton the saws become clogged. Lint when freshly separated from seed and when slightly moist through any cause is exceedingly adhesive and clings to the saws, and renders perfect action of the gin impossible. Thus gummed or clogged with wet cotton lint, the saws can no longer separate the lint and seed, and it is necessary to stop the gin, take out the cotton, remove parts of the gin, and clean the saws by taking off the wet lint by hand. The use of the invention obviates this trouble.

Musical Devices.

SELF-PLAYING PIANO.—H. Meyer, New York, N. Y. The object of the invention is to provide a piano arranged to insure accurate playing of the keys and with the proper touch and expression and to allow the use of a single note-sheet containing a number of pieces of music, only one of which is played at the introduction of a coin, the note-sheet being automatically rewound at the end of the last piece of music to start playing the first piece on the introduction of another coin.

MUSIC-LEAF TURNER.—E. R. Eldridge, Sumter, S. C. In the operation of this improvement the folio is placed upon the support with the back thereof engaged by clasps, and the individual leaves are engaged with jaws of the turning arms, all of said arms being arranged upon the right side of the support. When it is desired to turn the leaf, the uppermost arm may be swung to the other side of the support by means of a finger-piece.

Prime Movers and Their Accessories.

ROTARY ENGINE.—A. Glidie, New York, N. Y. This invention pertains to certain improvements in rotary engines adapted to be operated by steam, compressed air, or other fluid under pressure; and the object of the inventor is to provide certain improvements in means for controlling the admission and exhaust of the motive fluid in order to gain the maximum efficiency.

PUMP.—W. Y. Cruikshank, Freeland, Pa. This invention relates to pumps, and especially to rotary lift-pumps. The object is to construct a pump of the class described having an improved arrangement of the vanes whereby the efficiency of the pump will be much increased. When a rotation is imparted to the shafts the two hollow shafts will be rotated in the same direction, while the inner shaft which extends longitudinally within the hollow shafts will be rotated in a reverse direction.

Railways and Their Accessories.

CAR-REPLACER.—W. Cook, Hoboken, N. J. In this instance the invention relates to car-replacers, such as used for replacing derailed trains upon the track. The object of the improvement is to produce a device of this kind which can be readily set in position and which will be reversible in its nature, enabling the device to replace a car moving toward it in either direction.

HAND-CAR.—J. W. Finch, Elizabeth, Miss. In operation when the rock-lever is rocked upon its bearings the parallel arms are rocked about a counter-shaft, and since the stub-shaft is rigid with the pitman and a gear-wheel is rigid with the stub-shaft, another gear-wheel which meshes with the first one is constrained to rotate and carries the counter-shaft therewith at a much higher speed than were the parallel arms secured directly to the counter-shaft and acting thereon as a crank-arm, and since one sprocket-wheel is of relatively greater diameter than the other this movement is further multiplied on the axle.

Pertaining to Recreation.

FISHING-REEL.—G. W. Blackburn, Sarasota, Fla. The principal objects in this case are to provide reels with an improved friction-drag, with an automatic stop, with means for setting the drag for any desired pull, with a locking device to prevent the nut of the reel-post from working loose, and with other advantageous features without using any screws on the face of the device to injure the hands or any washers to wear out or clog.

Designs.

DESIGN FOR A HAND-BAG, PURSE, OR SIMILAR ARTICLE.—F. D. Kahn, New York, N. Y. The design in this case shows a hand-bag or purse suspended by a ring-linked chain. The form of the bag keeps well within the usual lines, yet exactly represents a sitting "Teddy Bear." The top of the bear's head and its ears are capped by the hinged frame of the purse. The figure of the bear is pressed in strong relief on the material used and a decidedly life-like and attractive result is secured.

Note.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Notes and Queries.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

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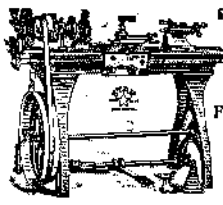
(10487) W. T. H. writes: In your reply to C. B. R. of March 16, page 239 (10437), you state in your closing sentence that "some" people "habitually use the right and others the left eye at their ordinary work." This is true. But is it not also true that when both eyes are kept open the alignment is always made with the right eye? Let any one with both eyes open hold out either his right or his left hand at full length of his arm, and then range the point of his forefinger with a distant object. Let him then while holding his hand steady close his right eye, and he will find that his finger is not in line with the object. But if he closes the left eye the alignment is perfect, provided the head and hand have been held steady. If there are any exceptions to this I have never yet found them, and I have tested a goodly number. There possibly may be people who are left-eyed as there are people who are left-handed. If so, the alignment with such must be made with the left eye. At any rate, when both eyes are open the alignment is made by but one of the two. It would seem, therefore, that the sportsman who keeps both eyes open has the advantage, since the closing of the eye not used tends to close the other also. Any way, I should advise the beginner to keep both eyes open. But to those who have long accustomed themselves to the closing of one eye, it is probably best to continue. A. We are not able to agree with you that a person always sights with the right eye when he has both eyes open. We have tested many classes of students, and have seen many who found the alignment perfect when the right eye was closed, that is, they were left-eyed. We have also many times in lectures upon the eye made the test on members of miscellaneous audiences, and found left-eyed people.

(10488) J. J. G. writes: Referring to query No. 10426, issue of March 16, second question: A claims that in foggy weather, when smoke descends to the ground, the atmosphere is light and will not support the smoke. B claims that it is heavy, and will not permit the smoke to ascend. Which is correct? You answer by saying: "When smoke falls toward the ground the air is light," so that the hot smoke is heavier than the air. In fine weather the air is heavier, and smoke rises." Now, if I am not presuming, I wish to differ with you, and to state my reasons: Moist air is lighter than dry air, but even so, it is difficult for me to reason that "hot smoke" would be heavier than moist air. It does not seem that hot smoke could descend till its loss of temperature permitted it to contract to the density of its neighboring strata. Then if the smoke remained drier than its neighboring strata, it would sink very, very slowly. But while the process of conduction is lowering its temperature, likewise the percentage of humidity is rising, and I believe it would soon adjust itself and become in equilibrium with its neighboring air before any lowering could be perceptible. However, it is a fact that smoke does descend in damp or foggy moderately tranquil atmosphere, and I attribute the cause to be due to the rapid coalescing of the water particles of the atmosphere on the dust particles of the smoke. These nuclei, which are the smoke, descend from the increasing weight of coalescing water particles upon them. A. There was no emphasis upon the *"hot smoke"* in the answer to query 10426, nor do we know why we used the word *hot*. It seems to us unnecessary, since smoke is always hot as it emerges into the air. Nor does the theory of the condensation of water upon the particles of carbon in the gases from the chimney seem to us to greatly help the matter, since it is a matter of common observation that the smoke does not first ascend in stormy weather while hot and then after cooling and taking on a load of water drop again. The fact is that smoke comes down instantly from the chimney top. Many a time the smoke of a train of cars at full speed gets down fast enough to fill the cars and be very uncomfortable when no wind is blowing. In the country we have seen the smoke of the chimney drop from the housetop into the yard close beside the house without any visible rise from the chimney. We still think the smoke rises in fine weather because it is lighter than the air at the time, and falls in stormy weather because it is heavier than the air at the time, without taking time to cool and take on water drops by condensation. Nor can the cooling of the smoke be by conduction as stated above, but by radiation into the air, since neither air nor carbon is a conductor of heat.

(10489) C. E. B. asks: 1. Is it theoretically possible to get as much work out of a permanent magnet as it takes to magnetize it? For instance, suppose a certain magnet takes 100 foot-pounds of work to magnetize it, and suppose further that the work done by this magnet at one lift is 1-10 foot-pound. Will it be possible to make the magnet do one thousand lifts, removing the armature each time by outside power? Magnet and armature to be laminated to prevent as much loss in currents as possible. A. The work done in magnetizing a steel magnet and the work which can be done with the magnet in lifting weights have no relation to each other. A magnet does not lose strength by lifting. It tends to gain strength rather. Pulling the weight off a magnet tends to magnetize it to a higher degree rather than to take away the magnetism. After a magnet has made one thousand lifts it should be in just as good condition as at first. Magnetism is a molecular condition of steel, and not an effect of work done upon steel. 2. If the magnet in No. 1 lasts for the thousand lifts, has it really done 100 foot-pounds of work? Is it possible that it uses up its total active power in the first lift, and that this power is restored to it (when the armature is pulled away) at the expense of the temporary magnetism of the armature and the outside power applied to move armature? A. If a magnet will hold up a pound, it may be used to lift a pound to any height desired, and it should not let the weight drop. When the weight has been raised 1,000 feet, the man who has lifted the weight has done 1,000 foot-pounds of work. The magnet has not done the work of lifting the weight. It has simply held the weight, and to hold a weight is not doing work. 3. What quantity of electrical energy in watts is necessary to magnetize a suitable hardened steel bar weighing 1 pound? A. We do not know the watts necessary to magnetize a bar of steel.

(10490) F. A. McD. writes: Referring to your answer to query No. 10428, for a process for electro-plating with aluminium, in your issue of March 16, I beg to refer you to Prof. Richards's book on "Aluminium," the last edition of which contains several formulas for this deposition, and is, I believe, a more reliable volume in this connection than the one you mention, Watt's "Electrodeposition." A. So many formulas for plating aluminium have proved unreliable that we should look with distrust upon any positive claim upon this subject. We give the above letter for our readers' benefit and can furnish the book for $6. We hope that reliable modes both for plating with aluminium and for soldering the metal will be found.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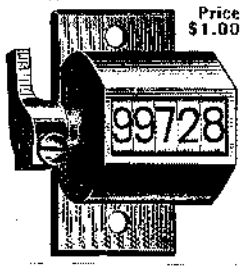

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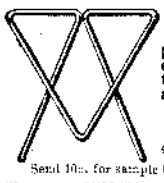
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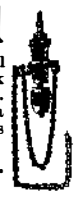

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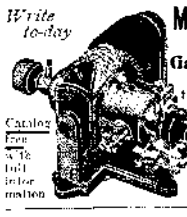
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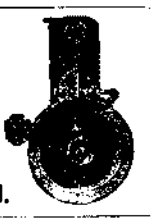

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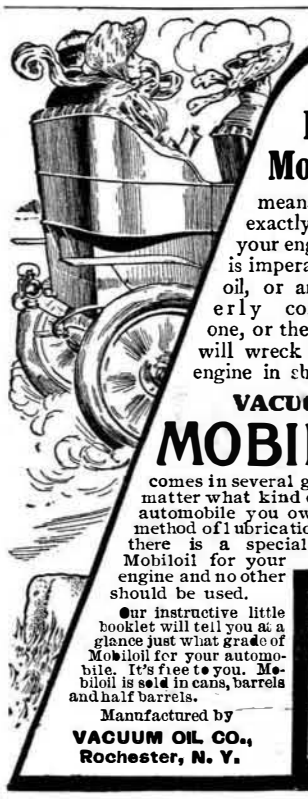

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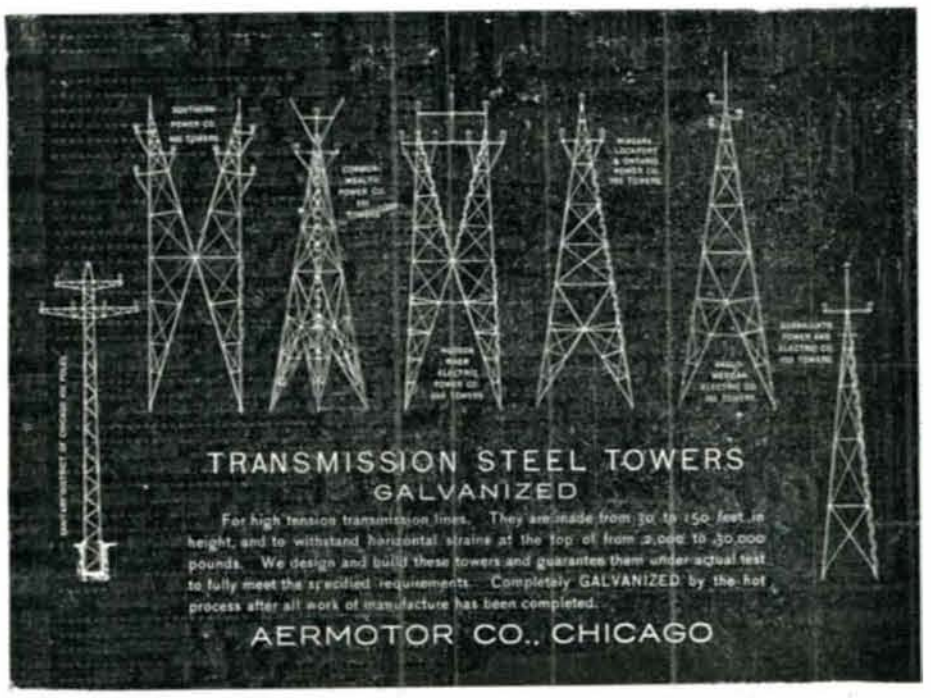
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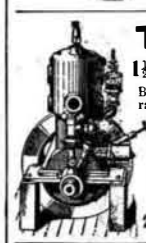

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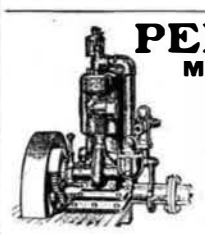

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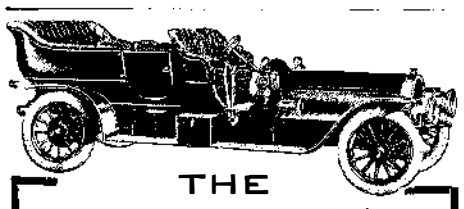

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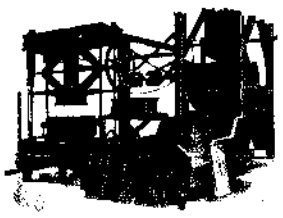

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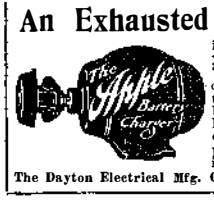

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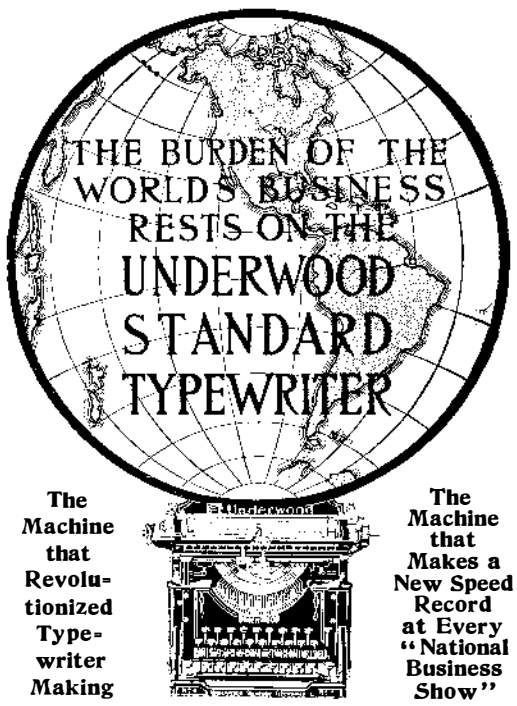

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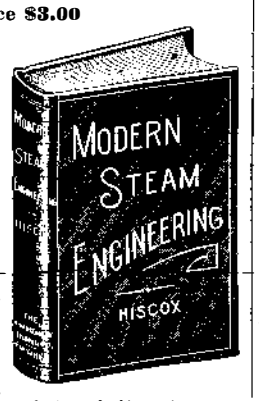

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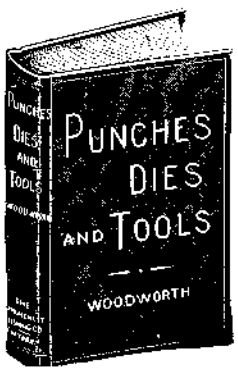

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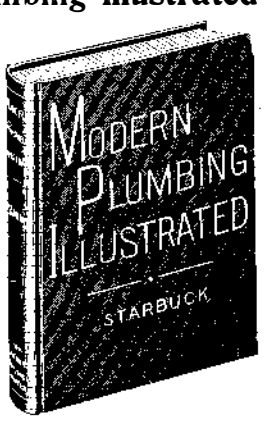

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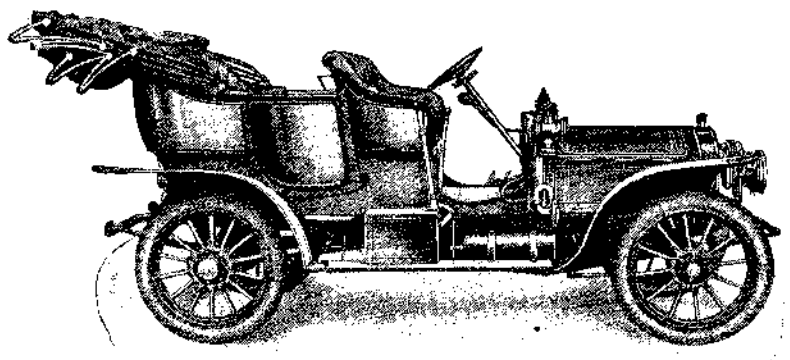

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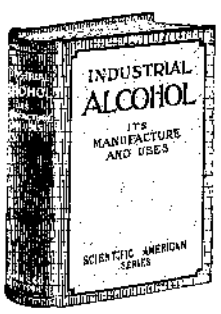

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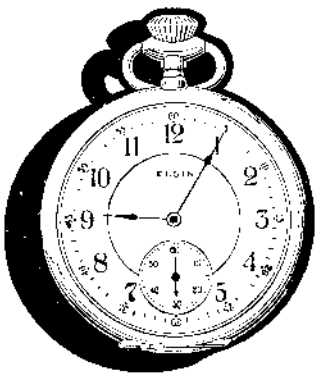

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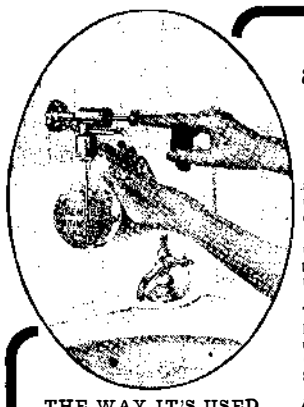

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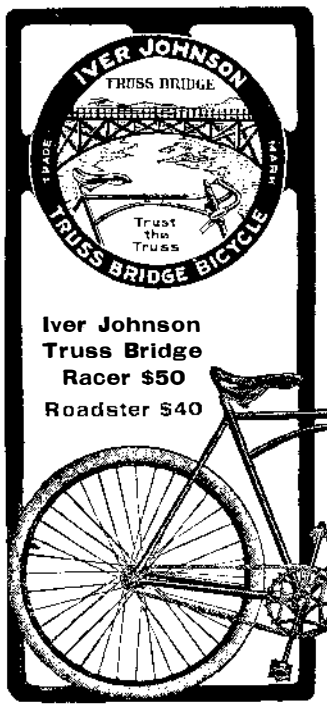

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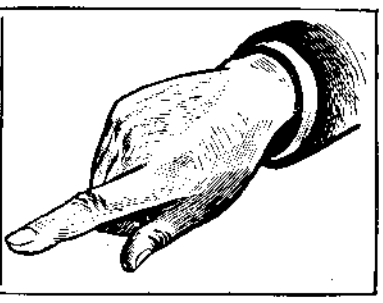

SEALED PROPOSALS.

PROPOSALS FOR CONSTRUCTION, Etc. Office of the Constructing Quartermaster, Fort Bliss, Texas, March 8th, 1907. Sealed proposals, in duplicate, for the sinking of a twelve-inch tubular Deep Well, installing a Deep Well Pump over same; for construcing a Deep Well Pump Shelter and Trestle; an 150,000 gallon Steel Tank on a 70 foot Trestle, and furnishing and installing two 40 H. P. Boilers, at this post, will be received here until 12 M., June 3rd, 1907, and then opened. Applicants for plans and specifications must enclose a signed receipt to insure the safe return of the same. Envelopes containing proposals should be endorsed "Proposals for Construction to be opened June 3rd, 1907," and addressed to the Constructing Quartermaster.

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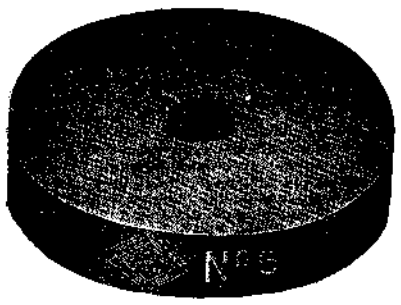

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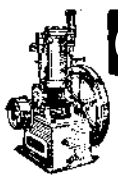

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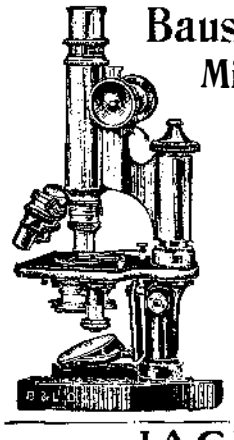

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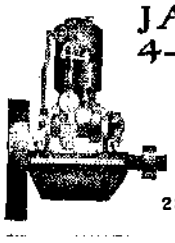

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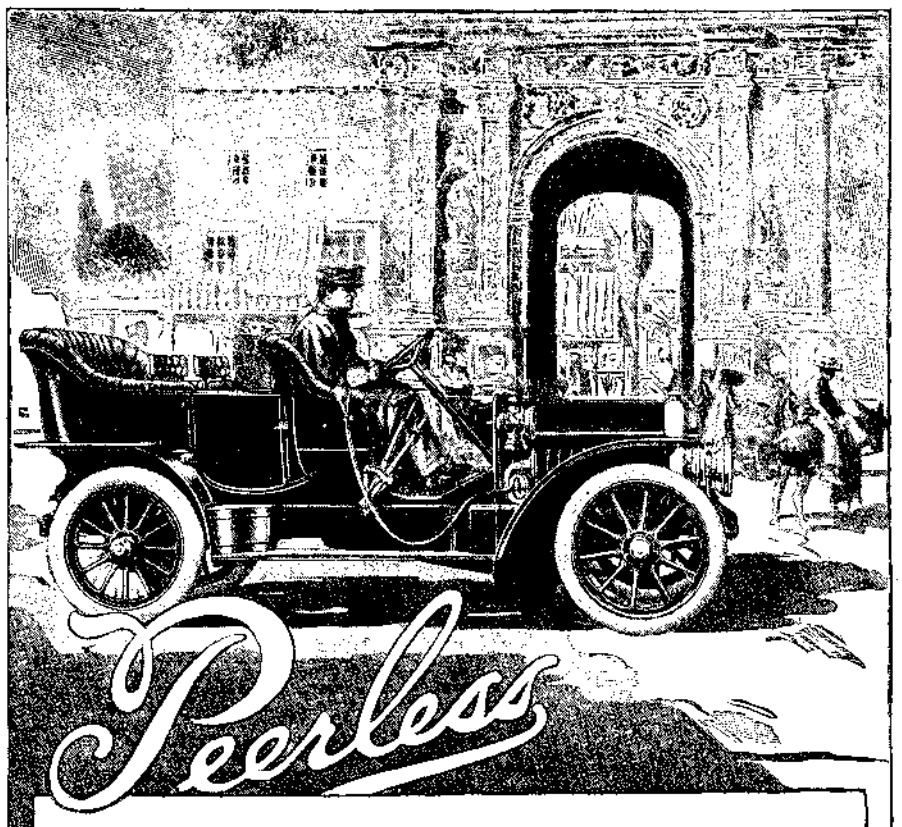

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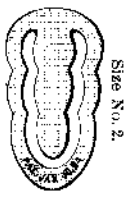

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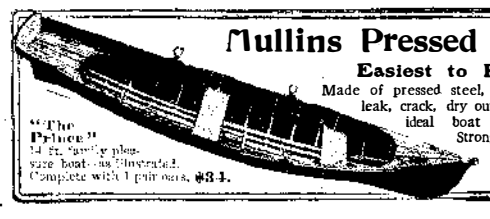

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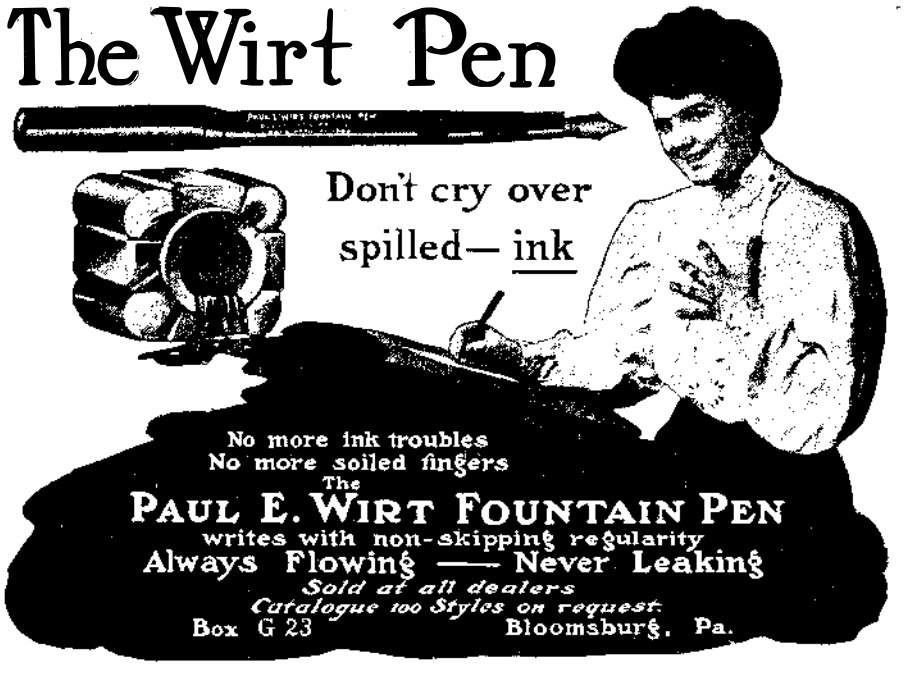
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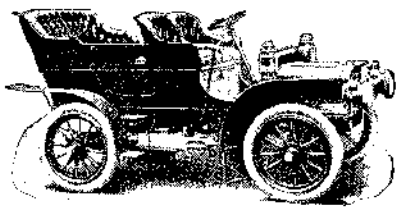

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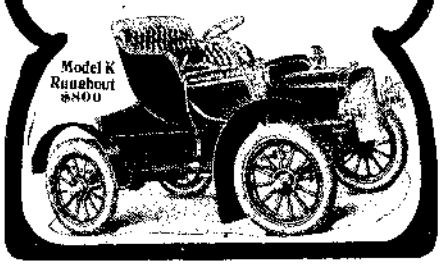

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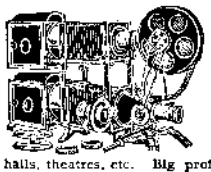

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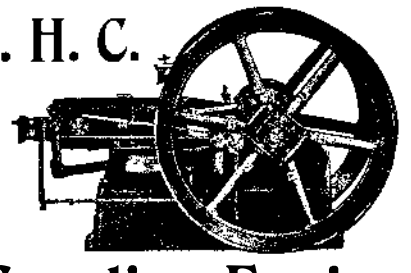

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